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## Direct Reading Electrical Measuring Instruments.

Professor W. E. Ayrton and Professor John Perry read a paper on the above subject before the Physical Society in London, January 26, 1884, of which we give below an extended summary. For the cuts we are indebted to the Electrical Supply Company, of 17 Dey Street, New York, who are sole agents for these instruments in the United States.

In the earliest form of instruments commercially employed for measuring the large currents used for electric lighting, viz., the instruments of M. Deprez, reference had to be made to a table of values to ascertain the meaning of any particular deflection, since there was no immediate connection between one degree deflection and one ampere; and, further, it was necessary to refer to the table twice over when measuring two different currents, as the deflections were not proportional to the current. By giving a proper shape, however, to the coil, needle, and to the pole pieces of the controlling permanent magnet, we succeeded, in 1880, in producing instruments in which the current, or potential difference, was exactly proportional to the deflection throughout the whole range of the scale; and, further, by the employment of our commutator principle, an instrument was obtained having two degrees of sensibility, one exactly ten times the other, so that a commutator-ammeter or voltmeter, although employed to measure strong electric currents and large potential differences, could be calibrated by the employment of a single cell of known electromotive force, but of totally unknown resistance.

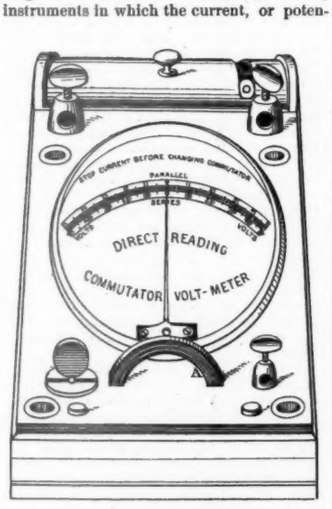


FIG. 2.

But these instruments possessed one serious fault, looked at from the users' point of view, and two others which especially concerned the manufacturer. The scales of all the instruments were divided into degrees, and although the deflections were proportional respectively to the current or to the potential difference to be measured, still there was nothing to show to how many amperes or volts one degree of the scale corresponded. Consequently for each instrument there was a "calibration constant," such as 1.75 amperes, or 2.14 volts per degree, which was determined experimentally by the makers. We have here two of this old type of voltmeter, in one of which 5.7 volts produces one degree deflection, and in the other 0.09 volts produces one degree, the former being intended for measuring electromotive forces up to about 230 volts, the other the electromotive force of a single cell. But the employment of such a constant had the very serious objection that, as all the instruments looked exactly alike, there was the great danger in any factory where several of these instruments were in use of the constant for one instrument being used accidentally for that of another. And this mistake not only rendered the answer, of course, quite wrong, but was liable to lead to the destruction of the instrument, or, at any rate, to the breaking of the pointer, from say an instrument having a constant 0.12 amperes per degree being put on a circuit through which 50 amperes were flowing, in consequence of the experimenter mistaking the constant for 1.2 amperes per degree. Further, even if no mistake be made in the constant, it is troublesome, except for those who are expert in mental calculation (a quality not always predominating in the men in charge of electric light circuits), to multiply a constant 3.17 by the deflection, say 21.32, quickly without the employment of paper and pencil.

FIG. 6.

FIG. 1.

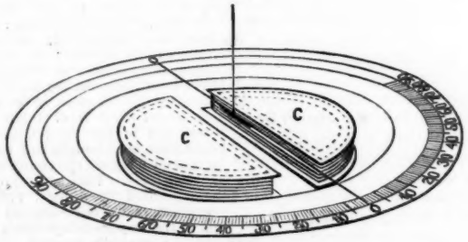


FIG. 4.

We therefore decided, not merely to avoid using tables of values, such as had to be employed by M. Deprez, but even to abandon the use of constants altogether, and to arrange matters so that the pointer pointed at once throughout the whole range of the scale, to the number of amperes or volts to be measured—to design, in fact, "direct-reading" instruments, and for the future we propose to confine the definition of an "ammeter," a "voltmeter," and an "ohmmeter" to instruments in which respectively amperes, volts, and ohms respectively can be *immediately* read off without any calculation or any reference to a constant, or to table of values.

In each case the dial is a complete disc (see Fig. 1) and not a sector, as in old instruments. The light aluminium pointer is also much longer, and the length of the graduated arc over which its end moves is also much greater, so that readings with the new instruments can be made much more accurately than with the old. We have a direct-reading ammeter suitable for measuring up to ten amperes, correct to a tenth of an ampere; and another for measuring up to 150 amperes, each division of the scale corresponding with one ampere. Again, each division of the scale of this voltmeter corresponds with one volt, this particular instrument being suitable for measurements up to 100 volts.

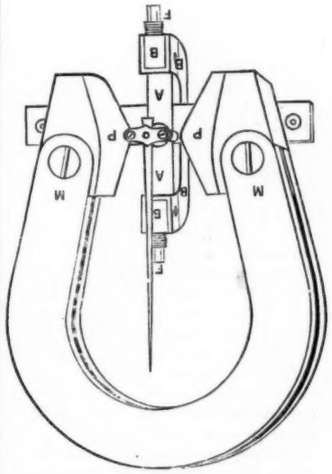


FIG. 3.

To construct a direct reading instrument, it is necessary to employ some form of adjustment for sensibility, since, to have a special scale engraved for each instrument after it was wound would be both troublesome and expensive; and further, if there were no power of adjustment, any change in the strength of the permanent controlling magnet would prevent the instrument any longer giving one division deflection pe

ampere or per volt: in other words, would then necessitate the employment of a constant.

It was important, to avoid complexity of construction, that the adjustment for sensibility should, if possible, be so contrived as to serve also for an adjustment for the proportional law. And this, we are happy to say, we have at last succeeded in accomplishing by fitting each end of the bobbin, round which the wire is wound, specially constructed charcoal iron cores fitted with a fine screw. If these cores be too far out, or out altogether, the proportional law will probably not be true, the current increasing more rapidly than the deflection. On the other hand, if they be screwed fully home the proportional law will also not be true, the deflection now increasing more rapidly than the current; but we find that between two limiting positions of these iron cores the proportional law is true, and by moving the cores in or out within these limits the sensibility of the instrument can be much altered without destroying the proportional law.

To construct then, say, a 50 ampere instrument, wire if selected of such thickness:—first, that 50 amperes will not heat it too much; secondly, that a sufficient number of convolutions can be wound on the bobbin for 50 amperes to deflect the needle to the limit of the scale when it is controlled by a permanent magnet of normal power. A scale, divided for 50 amperes, that is, having the division marked 50 amperes at the end of its range, is then put on, and the soft iron cores screwed in or out a little by trial until the pointer points to exactly the same number on the dial as the number of amperes of current flowing through the coil.

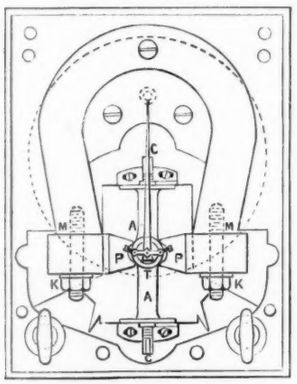


FIG. 5.

The "Ten Law" of our commutator instruments, which means that an ammeter is exactly ten times as sensitive when the commutator is turned to series as when to parallel, while a voltmeter is ten times as sensitive when the commutator is turned to parallel as when turned to series, is effected by the ten wires forming the bobbin having, inclusive of the resistance of the contacts at their ends, exactly the same resistance; which condition being fulfilled, it is quite unnecessary to obtaining the ten law that the ten wires composing the strand should be at all symmetrical in the way in which they are wound on the bobbins.

In our direct-reading commutator instrument the scale is double, as may be seen from Fig. 2, the upper numbers corresponding with the number of amperes or volts when the commutator is series, the lower when to parallel.

Fig. 3 shows the interior of the latest form. *A, A*, is the bobbin round which the wire is coiled. *M, M*, is the permanent controlling magnet, made in two parts to obtain considerable strength. *P, P*, are the soft iron pole pieces, of special shape, to be referred to further on. *F, F*, are the soft iron cores, and *B, B*, is a connecting bridge piece of charcoal iron used in our latest form of instrument for increasing the strength of the deflecting field for a given current, by connecting magnetically these iron cores together. This addition is very important in voltmeters, since although in an ammeter the constancy of the instrument is nearly independent of temperature, this is not the case in a voltmeter. The current producing a given deflection in either instrument is practically independent of temperature, but the potential difference necessary to be maintained at the terminals of the instrument to produce the current, and which potential difference is what the voltmeter is designed to measure, depends necessarily on the resistance, and therefore on the temperature of the coil. A temperature correction can be easily made for the portion of the effect arising from the temperature of the room; but the unknown amount of heating of the coil arising from the passage of the current it is far more difficult to allow for. Hence, it is generally necessary to be contented with a weaker controlling permanent magnet for a voltmeter, in order that the magnetic effect necessary to produce any given deflection, and consequently the heating effect, which is proportional to the square of this magnetic effect, shall be less in the case of a voltmeter than in an ammeter. But the employment of our soft iron pole pieces, combined with the soft iron bridge, enables us to use much more powerful controlling magnets, and therefore to obtain a much greater deadbeatedness, and a greater freedom from disturbance produced by extraneous powerful magnets, with our last form of voltmeters than with our earliest.

In an ordinary galvanometer, controlled by the earth magnetism, the strength of the controlling field is a uniform one, whereas the strength of the deflecting field produced by the current flowing round the coil is strongest in the plane of the coil, and grows weaker as we recede from that plane. Hence, when the needle is deflected, it moves into a weaker part of the deflecting field. The result of this is that the deflections for different currents increase much less rapidly than the current. If both fields be uniform for all positions of the needle, and be at right angles to one another when the needle is in its zero position, then, as is well known, the tangent of the deflection increases proportionately to the current. In order, then, that the deflection may increase proportionately with the current, one of these conditions must be fulfilled—(1.) The needle, when deflected, must move into a stronger part of the deflecting field, or (2) must move into a weaker part of the controlling field, or (3) both these results must be true. The first condition—uniformity of controlling field, combined with increase of strength of deflecting field—can be fulfilled by using two solenoids at a small distance apart from one another, but with a common axis, and suspending the needle between them, so that on being deflected it enters the solenoids, and therefore moves into a stronger part of the solenoid field, or it may be fulfilled by suspending a magnet over two flat horizontal coils, *C, C*, as shown in Fig. 4, the distance between the coils being rather less than the length of the needle, and the exact position occupied by wire being shown by the dotted lines. This mode we employ for making a rough students' laboratory galvanometer, with which the deflections are accurately proportioned to the current—at any rate, up to 45° or 50°. If, however, a dead-beat instrument is required, then, in order to ensure roughly uniformity of controlling field, the pole pieces, *P, P*, of the permanent magnets, *M, M*, must be hollowed out, as shown in Fig. 5, and must embrace the tube, *T*, in which the needle moves.

The augmentation of strength of the deflecting field is still further produced by the employment of the soft iron cores, *C, C*, referred to above, and which screw into the brass bobbin, *A, A*.

But condition 3, the needle moving into a stronger part of the deflecting field, and also into a weaker part of the controlling field, is the one we find the best, and it is the one we are using in all our latest instruments, the interior of which is shown in Fig. 3.

The ohmmeter we define to be an instrument in which the pointer points *at once* to the number of ohms required to be measured. The method we employ for making such an instrument consists in fixing two coils at right angles to one another, acting on the same soft-iron needle. One of these coils, having terminals, *T, T*, Fig. 6, is made of thick wire, and is placed in series with the resistance to be measured, while the other, having terminals, *T, T*, is composed of very fine wire, and is put as a shunt to the unknown resistance. Hence the main current produces its effect by means of the thick wire coil and the difference of potentials at the terminals of the unknown resistance on the fine-wire coil. Now, by properly proportioning the shapes of the coils, and by winding these coils in a definite way, we have obtained an instrument in which the deflection of the pointer is exactly proportional to the number of ohms, and which we find most convenient for measuring the resistance of any part of an electric circuit, such as the field magnet of a dynamo, or the resistance of an arc lamp while the strong current is flowing. The thick coil is always kept, like an ammeter, in the main circuit, and the terminals, *t, t*, of the fine wire attached to any two points the resistance between which at any particular moment it is desired to know. The use of the instrument also permits the employment of an iron wire, or even of a bit of wet rope, as a resistance coil for experimental purposes, the resistance of the iron wire, or of the wet rope being determined with the ohmmeter at the moment the experiment is being made.

## Annual Report of the Directors of the American Electric and Illuminating Company.

The annual meeting of the stockholders of the American Electric and Illuminating Company was held in Portland on Saturday last, President Edward H. Goff, of Boston, in the chair. In view of the interest evinced by the public, and especially by the company's stockholders, in the actual condition of the company's affairs, and especially on account of the numerous reports which have been circulated, derogatory to the company, the annual report of the directors will be read with great interest. It is as follows:

The directors of the American Electric and Illuminating Company herewith submit their first annual report to the stockholders of the company for the fiscal year ending April 30, 1884

### HISTORY OF THE COMPANY.

Before proceeding to record the work of the year, it may be well to refer briefly to the previous history of the company.

The American Electric and Illuminating Company was organized in June, 1882, under the general laws of the State of Colorado, but the company did not get its business fairly under way until the following December, or beginning of January, 1883, therefore this report really covers a business of sixteen months. The object of seeking a charter from a State so far distant was two-fold. First: its laws permit the stock to be divided into shares of $10 each, bringing them within the reach of persons of moderate means, and do not require the entire capital to be taken and paid for before business can be begun, as does the Massachusetts law, but permit a company to hold unissued stock in its treasury, to be sold from time to time as its needs may require. Second: Its laws are simple and easily complied with in changing to those of another State. The laws of the State of Maine are similar to those of Colorado in these respects, but at the time mentioned they limited the capitalization of companies formed under them to an amount comparatively small. Subsequently, this latter provision of the Maine laws was amended, and in September, 1883, the company was reorganized, and now holds its charter under the laws of Maine. Organization under the laws of Massachusetts would have been preferred for many excellent reasons, but they require, in the first place, that all shares shall be of a par value of $100 each, and in the second, that every share shall have been bought and fully paid for in actual cash before the company can transact any business. This latter provision is very often evaded by a legal fiction, but the incorporators of your company did not care to incur the responsibility which such a course would necessarily involve

The nominal capital stock of your company is $1 000,000, divided into 100,000 shares of a par value of $10; of these shares 25,000, representing $250,000, are *preferred*, and the remainder, 75,000, representing $750,000, are *common*. The preferred shares have all been sold for cash at par, yielding $250,000 to the treasury. The common shares have been used for the acquisition of franchises, rights of way, etc., given as bonus with the preferred stock first sold, and in other ways to promote the business welfare of your company, and represent no money whatever received by the treasury. The actual cash capital of your company, therefore, at the present time, is the $250,000 represented by the preferred shares. Upon this there is a fixed charge of eight per cent. per annum, or $20,000. Any excess of profit over this amount, if divided goes to the common and preferred stock alike March 1, 1883, the preferred stock received its regular semi-annual dividend of four per cent., September 1, 1883, and March 1, 1884, the preferred stock received, besides the regular semi-annual dividend of four per cent., an additional dividend of two per cent., giving it six per cent. semi-annually, or twelve per cent. per annum, and the common stock received in each of the months last named a semi annual dividend of two per cent., or four per cent. per annum on its par value. The indications are that not only can these generous dividends be maintained, but that, if your directors are enabled to carry out the plans that have been proposed, they can be very largely increased in the near future.

As has been already stated, your company, although organized in June, 1882, did not really get to work until early in the following winter. It obtained from what is now the Thomson-Houston Electric Company—then the American Electric Company of New Britain, Conn.—a lease and license to operate the Thomson-Houston system in the city of Boston. A small station was established in the basement of the building belonging to the Massachusetts Charitable Mechanic Association on Huntington Avenue, a few small dynamo machines were put in, wires were strung, and business was begun on a very limited scale. It was the hope and ambition of your directors at that time to establish a lighting business in the city of Boston, and in time to share the business of the city with the Brush and Weston companies already established. Of the obstacles which met them at every turn it is needless here to make mention. Every possible means was resorted to to throw discredit upon your company and its management; false and scandalous charges were freely made, but the business continually grew, the stock continued to sell, putting your treasury in funds with which to purchase additional machinery and extend its business, and before the winter of 1882-3 was over the business of your company was on a firmly established basis.

The excellence of its light, its pure white color, its steadiness, and comparative economy of production, began to attract very general public attention, and applications were received from several New England cities asking your company to establish and operate plants therein. This your directors hesitated to do, believing that they could not do justice to a business which was scattered in a number of cities, for they fully realized that a lighting company, to be operated successfully and profitably, must have careful local management. Accordingly your directors decided to establish a constructing department in connection with their lighting business, but separate and distinct from it, whose business it should be to construct complete plants wherever required, these plants, when completed and in operation, to be sold to local lighting companies. To carry out this plan it became necessary to enter into a new arrangement with the Thomson-Houston Company, from which a concession of territory covering the whole of New England, save certain sections which had already been ceded to other parties, was obtained.

It is perhaps fortunate for the stockholders of the American Electric and Illuminating Company that their directors could not, at the time they decided to open up this important branch of the company's business, foresee what was before them. Had they realized how the flood-gates were to be opened and abuse and misrepresentation poured upon them, it is altogether probable that the company would to-day have been doing a simple lighting business in Boston, and that gas would still continue to serve the purpose of making darkness visible in the streets of Fitchburg, Lowell, Hartford, Worcester, and other cities which are now brilliant with the American light. But, once started on this course of development, no backward course was thought of, and abuse and slander were in every case squarely met and victoriously overcome So virulent was the opposition, so given over was it to falsification of plain facts, that its course rather aided than obstructed your directors in their work, for the public, that great court of equity which searches men's motives, saw that your company and its light were opposed because they were feared, and that the arguments offered were in reality a tribute to their merit.

### BUSINESS IN BOSTON.

During the summer of 1883 it became apparent that the department of construction would require all the attention of your directors and of the officers and expert employes of your company, and that they could not devote the time and care required for the proper development of the large lighting business which had grown up in the city of Boston. Accordingly the Boston plant and

business were sold and transferred to the Merchants' Electric Light and Power Company, which now carries on the lighting business in Boston under license from the Thomson-Houston Company. Its needs had outgrown the modest station originally established in the basement of the Charitable Mechanic Association's building, and your company therefore contracted to construct for it a station of suitable capacity in a central location. The fine granite building now occupied by the company on Congress St. was secured for the purpose, provided with a first-class equipment of boilers and engines, so arranged as to work with the greatest possible economy, and as it stands to-day it is by all odds the finest and best equipped arc lighting station in this country, if not in the world. Of this building the cellar and first floors are occupied by the Merchants' Electric Light and Power Company, the floor above by the offices, and supply department, of the American Electric and Illuminating Company, and the floors above are to be occupied by the Electrical Development and Manufacturing Company, a corporation organized for the purpose of enabling inventors to develop and perfect electrical inventions, and for the manufacture of electrical appliances and devices of all sorts. Thus the building from cellar to roof will be an electrical establishment, representing a number of varied interests; all, however, closely allied and mutually helpful.

Before proceeding to a detailed mention of the operations of the company in the cities of New England, outside of Boston, your directors deem it but just to the management to say that a very serious obstacle to the accomplishment of their plans in the form of a falling market and a disinclination to invest in new enterprises, has been met and overcome in a gratifying measure. Values of all sorts have been gradually shrinking during the two years last past; money, though plenty in the banks, has been scarce among the people; incomes have been sharply reduced, and liquidation has been very general. It has not been easy, in view of this state of affairs, to interest local capital in lighting enterprises, and when we add to these obstacles the opposition which has been set up by the gas interest and by competing electric light companies, we feel that the progress that has been made and the work that has been accomplished should be a matter of gratification to every stockholder of the company.

### THE FUTURE OF ARC LIGHTING.

As to the future of electric lighting by the arc system there can be and is no question whatever. Not only do we find in every city where a plant is in operation that the number of customers is increasing, but, what is quite as important, that old customers are steadily increasing the number of their lights, so that the average number of lights used by each customer is constantly increasing. The reason is not hard to find. A man puts a light at the door of his store, originally, it may be, to attract customers—as an advertisement, in fact. It illuminates the sidewalk in front of his store, and casts some rays into the store itself, but only into the front part. The back of his store, where the gas jets burn with a sickly and yellow glare, looks dim and unattractive. The next step is to put a light into the middle of his store. Meantime, a competitor has put four or six lights into *his* store, and banished gas entirely. It is flooded with light in every corner, there is no heating or vitiation of the air, and customers are not only attracted, but *held*. There is but one course for the first man to take. He floods *his* store with light, and tries to out-do his neighbor so as to bring back such of his customers as have strayed away. One might as well expect a city which has long had gas to abandon it and go back to tallow candles and whale oil as to expect business men whose stores have once been lighted with arc lamps to go back to gas, with its sickly light, its noxious fumes, and its heat.

In the matter of street illumination the growth of the use of electricity is remarkable, considering the efforts that have been put forth against it. In every city which uses gas the gas company is and always has been a *power*, financially and politically. In carrying on its own business it has always found it not only convenient but necessary to hold the reins of political power as far as possible, in order to keep control of lighting contracts and to maintain the right to dig up the streets at its own convenience, regardless of that of the public, for the purpose of placing or repairing its pipes. In most cases it has been long established, and having a practical monopoly of the lighting business, it has grown rich. In almost every city its wealth and its long-held political power have been pitted against electric lighting, and hence it has been a matter of some difficulty for the electric light to gain a footing for street lighting. But its manifest and undisputed superiority for the purpose, its value as a factor in the prevention and detection of crime, the universal favor with which it has been received by the public, and the demand for its general use in every city where it has been introduced on a small scale in the beginning, have aided it greatly, and it may safely be asserted that the use of electric lights in the streets of all our cities is destined to very greatly increase within the coming twelve months.

As an indication of the recognition by the gas companies of the need of more lights in the streets than they formerly furnished, it may be mentioned that in many cities the gas companies erected large lamps, burning each from six to sixteen times as much gas as the ordinary street burner, in prominent locations, and burned them for some months at their own expense. The largest of these give, at best, less than one-third the light afforded by an arc light, and yet, when they had got tired of running them for nothing, and had cut the price of gas per thousand feet down one-third, it was found that each of them was to cost the city just about double what the city was paying for each electric light. These "torches," as they are called, were set up at great expense for the purpose of showing that gas could compete successfully with electricity for extensive illumination, but the result has been most disastrous to those concerned in the undertaking.

### THE CLAMOR FOR UNDERGROUND WIRES.

A great deal has been said during the year in the public press and elsewhere concerning the necessity of putting electric light wires underground, and the opponents of electric lighting have been quick to sound an alarm concerning imaginary dangers growing out of the use of overhead wires. It was pointed out that they were a fruitful source of danger, and numerous cases were cited, with full details, where life and property were destroyed through their agency. Your directors were at pains to investigate these cases thoroughly, and can report that in most instances there was not a shadow of truth in them, and that in the others what little fact underlay them was magnified out of all proportion to its intrinsic value. It was at first difficult to understand who it was that was sufficiently interested to not only manufacture falsehoods outright, but to procure their insertion in reputable newspapers, which not only gave them prominent place, but made them the subject of leading editorial comment. But when it was discovered that a company was organizing in New York to construct underground conduits for all classes of electric wires, and that it was the intention of this company to seek from the Legislature of the State the sole right to dig up the streets of the metropolis for this purpose, to secure which a strong public sentiment based on fear would be very helpful, the moving cause and the motive became apparent. The scheme of the promoters of the company named was nipped in the bud, and, singular to relate, there have been no accidents from electric light wires from that day to this.

But another agency was at work in the same direction, and though the cry, "The wires must go underground," has nearly ceased in New York, certain newspapers in Boston and other New England cities, noted hitherto for their opposition to all electric lighting enterprises, have taken up the refrain and chant it at intervals with parrot-like iteration. The several heavy and soft snow storms during the past three or four months, which have caused great damage to the suspended wires of the telegraph and telephone companies, have been seized upon as the text for numerous diatribes upon the dangers and inconvenience of overhead wires, and to each has been appended the monotonous chorus, "The wires must go underground." We have said that the snow storms of the past phenomenal winter and spring have caused great damage to telegraph and telephone wires. Electric light wires have been advisedly omitted from this enumeration, as the damage to them has been so slight as to require no special mention. There are two reasons for this: First, the number of such wires compares with that of the telegraph and telephone wires only as units to hundreds or even thousands; second, the superior strength of the wires and fixtures, and the freedom from adhesion of snow to the insulating covering of these wires, has rendered them virtually exempt from damage from this cause. Even in the heavy sleet storms of February 27 and 29, in which the wires and structures of the telephone and telegraph companies were prostrated on every hand and vast damage caused to them, hardly an electric light wire was thrown down.

In the wrecked and tangled condition of the telephone wires, it was deemed by the management of the New England Telephone and Telegraph Company that danger of "crossing" with electric light wires, by which telephone magnet coils might be destroyed, existed, and on their request, and that of Mayor Martin, the electric light companies consented to suspend the running of their lights during one night. But it is a noteworthy fact that the day circuits of the electric light companies were run as usual during the entire day with no injury or damage whatever, and that the danger, if any existed, from this source had entirely ceased before the suspension was requested.

In view of these facts, it is evident that something more than the ostensible reasons assigned underlies the clamor for underground wires. The opponents of electric lighting, not daring openly to oppose the public sentiment in their favor, hope by securing legislation to compel the burying of the wires to embarrass and obstruct their operation. Of course, no argument is required to prove that the managers of electrical companies are far more deeply interested than any body else can possibly be in the perfection of a practicable and successful system of underground wires, but thus far no such system has been presented, and the experiments in that direction which have been tried have proved costly failures. Wherever hostile legislation has compelled the placing of arc-lighting wires underground, as in Paris and London, though the facilities for the successful working of subterranean wires in those cities are far better than in any American city, the result has been great injury to the business of the companies and in some instances their virtual ruin. It is fair to conclude, therefore, that the real object of much of the manufactured "sentiment" in favor of placing the wires underground is to prevent the extension and successful operation of electric lighting.

In this connection, an extract from the annual report of the directors of the American Bell Telephone Company will be found interesting and instructive:

"It is desirable that the difficulties attending any radical change from the present overhead system of wires should be better understood. It is common to see in the public papers round statements that the wires ought to be at once ordered underground. In this matter we and our associates have the strongest motive for wishing to get wires underground as far and as soon as it can be done without destroying the efficiency of the service. The plant would be more permanent, and no longer liable to interference from municipal authorities or individuals, or destruction from storms, and its maintenance would be cheaper and easier. But, although short trunk lines work fairly well beneath the surface, as shown in Boston and elsewhere, in the present state of the art it is impracticable to put the bulk of the wires underground without interfering seriously with facilities upon which the public are now getting to depend."

It is gratifying to note that the efforts of these opponents of electric lighting have thus far met with repulses at every point, and that as legislators become acquainted with the facts in the case, the difficulties in the way of operating underground wires, and the efforts being made in good faith by the electrical companies to solve the difficult problem, they refuse to lend themselves to any scheme to embarrass and hinder the companies, and vote, as did the Massachusetts Legislature at its present session, "inexpedient to legislate."

### ELECTRIC STREET LIGHTING IN CITIES.

Just one month ago to-day your President addressed a circular letter to the stockholders of the company, in response to many letters expressing alarm lest the city of Boston should discard electric lights in whole or in part, and thus depreciate the value of the stock of the company. An extract from this letter will be found of interest in the present connection:

"These apprehensions have been occasioned by the reports industriously circulated that a large reduction in the number of electric street lights in this city would be made by the present City Council, on the alleged ground that these lights had proved an expensive luxury and were not worth their cost. The keynote for these statements was sounded in Mayor Martin's inaugural, wherein he expressed the idea that the city could with profit and propriety confine the use of electric lights to public squares, the vicinity of railway stations, and similar places, and return to gas for general street illumination. The public uneasiness on the subject was largely increased by a long article in the *Boston Herald*, purporting to give the plans of the Committee on Lamps of the new Board of Aldermen, in the direction of carrying out these views of the Mayor. Interested parties at once made a lever of these assertions and arguments to sustain their opposition to electric lighting, and it was published all over the country that Boston had tried electric lights, had found them too costly, and had decided to abandon them.

"During all this time, and amid all these attempts to manufacture sentiment against electric lights, we have quietly pursued the even tenor of our way, knowing that the public generally was in favor of the lights, whatever might be the wishes of interested parties. The proof of this was seen in the numerous petitions and remonstrances, from all classes of citizens, which were handed in to the city government, protesting against any diminution of the electric lighting of the city. Finally a firm, dignified, and respectful memorial, setting forth the reasons why the electric lights, instead of being decreased, should be increased, was prepared, and more than willingly signed by a very large number of representative and prominent business firms and individuals, and was presented to the city government on the 24th ultimo Double the number of signatures could have been secured, had time permitted, but the names affixed represented a very large part of the taxpaying wealth, business enterprise, and influence of the city. This memorial asks that the appropriation for electric lighting be increased from $94,000, as estimated by the auditor, to $125,000. At every stage efforts were made by the opposition to cut it down below the figure first named, and the Committee on Estimates reported in favor of $95,000; but when the question came up in the Board of Aldermen and in the Common Council, the members of which knew the public feeling, the amount was raised to $125,000, the exact amount asked for by the memorial.

"Nor is it in Boston alone that the public gives proof of an increased desire to have the streets illuminated by electricity. A year ago the city of Lowell's appropriation for electric street lighting was $10,000. This year it is $40,000, and it is already certain that next year it will be larger still. Last year Providence had sixty Weston lights in her streets. These have been discontinued, and seventy-five American lights shine on her streets, showing an increase of twenty-five per cent. It is probable that before the year closes this number will be doubled. Worcester was late in the field, but has a 200-light American plant in operation, and has some fifty or sixty lights on the streets. Hartford, Conn., after a long and bitter fight by the gas interest, has placed thirty Thomson-Houston lamps on the streets, and is now talking of largely increasing this number. Fitchburg, Mass., Lewiston, Me., and other New England cities have adopted the Thomson-Houston lights, and Portland, Me., and other cities are considering favorably the like action. In a word, the business is now firmly established on a permanent commercial basis, and, although there are still those who lose no opportunity to oppose the introduction of the electric light, it has too firm a hold upon the public, and serves its purpose too satisfactorily to be dislodged. *It has come to stay.*

"In this connection it is gratifying to be able to report that all the lighting companies established by the American Electric and Illuminating Company are doing a prosperous, growing, and paying business, and that our light, whenever brought in competition with others, is unhesitatingly pronounced *the best.*"

### THE SUB-COMPANIES.

In addition to the Merchants' Electric Light and Power Company, to which the Boston lighting business has been transferred, and whose central lighting station, with a capacity of 1,000 lights, has been briefly described above, this company has established lighting plants and organized sub-companies, to which the plants have been sold in various cities and towns of New England. The earliest of these outside developments was in Lowell, Mass., where a small plant was established in 1883, in the face of the bitter opposition, not only of the gas company, but of a strong company using a rival system of electric lighting. The most strenuous efforts were made to prevent the Thomson-Houston system from gaining a foothold in Lowell, and every endeavor was used to prevent the city government from giving our company rights in the streets or recognition in the matter of lighting. In the course of a few months, however, so generally was the superiority of our system recognized, and so rapid in consequence had been the increase of our business, that the chief owners in the rival company, seeing the futility of further opposition, made overtures for a union of interests, which were accepted by your directors, and the Middlesex Electric Light Company was organized, in which both interests are represented. Among the gentlemen prominent at first in the competing company, and now foremost in the directory of the Middlesex Company, and in advocacy of the Thomson-Houston system, are Messrs. Ingham, Downs and Glidden, of the well-known Lowell telephone syndicate, whose financial standing, energy and business sagacity make them a tower of strength to the company. This company, organized with a capital of $150,000, is now running a plant of 250 lights, and is earning net some 12 per cent on its capital. Regular eight per cent. dividends have been paid by this company since its organization, and it now has one of the finest stations and lighting plants in the country.

The next outside plant to be established was in the city of Fitchburg, Mass., where the directors of the Wachusett National Bank took up the entire capital stock of a new company, called the Wachusett Electric Light Company, and began business with a 100-light plant. During the first three months of the company's existence, with 86 lights in operation, one and one-half per cent. was earned on the capital of $100,000, one per cent. of which was divided to the stockholders, and the balance was turned over to the construction account. The plant was increased to 125 lights during the past winter, and the growth of the company's business has brought about a corresponding increase in its earnings, so that the Wachusett Com-

(*Continued on page* 8.)

# Electrical Review.

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*We extend to manufacturers of electrical apparatus an invitation to send to this office any and all facts concerning their business which will be of interest to the public. We make no charge for publishing news.*

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NEW YORK, MAY 31, 1884.


CONTENTS.


| | PAGE |
|---|---|
| Direct Reading Electrical Measuring Instruments | 1 |
| Annual Report of the Directors of the American Electric and Illuminating Company | 2, 3, 8, 9 |
| Editorial Notes | 4, 5 |
| Educating Telephone Subscribers | 4 |
| Western Union Again | 4 |
| The Providence Telephone Company's Report | 6 |
| Underground Wires | 6, 7 |
| Telegraphic | 7 |
| Telephonic News | 6, 7 |
| Electrical and Scientific | 8 |
| New Sodium Battery | 9 |
| Conductivity of Copper | 9 |
| Electric Light News | 9 |
| Electrical Patents | 10 |


The prompt and business-like way in which the Faraday did her work at Rockport, and her abrupt departure as soon as it was done, put a damper on the intended celebration, and rather disappointed the Rockporters. But the fact is that, as the laying of cables is a matter of pure business with the Faraday and her officers, the novelty of the thing all wore off long ago, and time is too precious and costly a commodity to be wasted in gush, when it involves delaying an enterprise the running expenses of which are counted by thousands of dollars every day.

Going about from place to place, one sees all sorts and conditions of electric lights, and it does not take very much of an eye to see that they differ very materially, the one from the other, in illuminating power; but each and every one of them is alleged to be of 2,000 candle-power. Isn't it about time to give up this "nominal" standard, and come down to solid facts? Some say that the true way to get at the candle-power of an arc light is to measure it on four sides, and add the results together. How would it to do to measure it on four sides and take the average? This is merely a suggestion, but we should like to hear from some of our readers who have experience in the matter.

The annual report of the American Electric and Illuminating Company, given in full in our present issue, will be found to contain much information of value to all who are engaged in electrical pursuits, more especially those connected with electric lighting. It takes the ground that electric lighting is but in its infancy as yet; that it is surely destined to see very great and very rapid development, and certainly gives excellent reason for the faith expressed. This company holds a somewhat unique position, owning no patents, yet doing a very large business in constructing arc lighting plants. Its experience has been large and varied, and, as detailed in the report of the directors, is full of interest.

We hardly expected that the drag-net would have meshes fine enough to hold so small a fish as "Steve" Moriarty, whilom associate of the Grant boys in their electric light venture, but we learn from the daily press that this curious and interesting specimen has been brought to the surface. There was one thing about his evidence the other day that we fail to grasp. He says he has no property, except two or three suits of clothes, and almost in the same breath he says that he resides at the Fifth Avenue Hotel. Most folks that live in that cheerful hostelry make a little deposit with the cashier at stated intervals; but as "Steve" has nothing, it is hard to see how he can comply with the rule. Speak up little man, and tell us how it is done.

In the Massachusetts Legislature a letter was read by a member, the writer of which offered to go before a competent tribunal and give explicit evidence, with names and dates, showing that certain members of that august body were offered bribes to kill the water-gas bill, the presumption being that they were offered in the interest of the Boston Gaslight Company, which was very forward in opposing the measure. In view of this, the lower house voted to appoint an investigating committe; but the Senate, two of whose members are said to have experienced sudden conversion, wrapped itself up in its dignity and refused to concur. All of which leaves the Senate and the gas company in a very unenviable and questionable position. It would have been far better to face the music.

We are glad to see that there is quite a number of non-electric telephones—a sort of amended and improved "lovers' telegraph"—in the market, and trust that they are all doing well. To guard against mistakes, we desire to add that this is *not* "wrote sarkastick." On the contrary, quite the reverse. The non-electric telephone has its uses. Its first use is to teach men by experience how handy it is to have a device that will enable them to speak with somebody in one particular place a short distance away; and its second use is to teach them how much better it would be to have a device that would enable them to talk with a great many people scattered in a great many places a long distance away. It leads straight up to the electric telephone. It educates men to become subscribers to the nearest exchanges, and as an educator it should be encouraged by telephone men.

## *EDUCATING TELEPHONE SUBSCRIBERS.*

Very many of the unreasonable demands and complaints, on the part of subscribers to telephone exchanges, grow less out of a desire to find fault than out of ignorance of the limitations which necessity imposes upon the exchange itself and those who operate it. It would indeed be well if every subscriber could have these explained to him, and if he could be made to understand the fact that in ninety-nine cases out of every hundred the operator is as anxious that he should have good service as he himself possibly can be. The man who calls up the central office is very apt to imagine that just at that moment the operator is sitting with hands folded waiting for something to do, whereas, as a matter of fact, it is altogether probable that just at that time she is serving some other subscriber, who has an equitable right to be attended to before the new applicant's wishes are complied with. Here is a point that is not sufficiently impressed upon subscribers. As a rule, they are reasonable people, and a little explanation in this and other directions would serve admirably to allay the impatience which, under a false conception of the possibilities in the case, they not unfrequently manifest. We take it for granted that every exchange manager knows that it is of the utmost importance that every operator should be courteous in talking with subscribers, and meet impatience with forbearance; but it is also clear that enough has not been done in the way of educating subscribers, who are, in a certain sense, and when they are using their instruments, as much operators as those who sit in the central office and answer calls. Nine subscribers out of ten, when they fail to make themselves heard distinctly, aggravate matters by raising their voices, whereas it is distinctness that is wanted, not noise. There is no more convincing proof of this than to go into the operating room of a large exchange and see in what comparative silence the work is done. A subscriber who has once been taken into such a room, and has seen for himself that forty or fifty operators can, sitting side by side, talk with subscribers in a tone so low that one cannot hear what her next neighbor is saying, will remember it, greatly to the benefit of service over his line, and to the relief of those whose misfortune it has been to be in his vicinage while he has been conversing. It should be the aim of managers to impress it upon subscribers that they can safely confide their messages to the *transmitter* without a thought of the wire beyond or the person at the other end of it. They should be told to look the transmitter squarely in the face, to learn by experience to graduate the proper distance of the mouth from it, and then to speak low, though distinctly.

They should further be taught that a telephonic transmitter is a very delicate piece of mechanism, that to endeavor to adjust it is no part of their business, and that the manager will be thankful to them if, in case of any failure of the instruments to work properly, they will report the fact, in order that a competent person may be sent to adjust them. Many a subscriber has done serious injury to an instrument by trying to "doctor" it himself, when the simple turning of a screw by a competent hand might have remedied the whole difficulty in a minute, and saved both hard feeling and hard language.

## *WESTERN UNION AGAIN.*

The competition which has been set up against the business of the Western Union Company, and the present depreciation of the market value of its stock, has again brought to the front those who claim that its plant can be duplicated for one-fourth of the money which its plant represents; that the other three-fourths is therefore water; and that a new company coming into the field with sufficient ready money can not only duplicate its plant, but take away its business, and earn generous dividends at rates which would be ruinous to Western Union stockholders.

We have nothing to say in favor of the methods resorted to to raise the capital stock of Western Union to the present enormous figure, which, in the present attitude of affairs, is, to say the least, exceedingly unfortunate. But, on the other hand, the idea that the capital should justly represent actual, visible plant, and nothing more, is absurd. The company has something more than the wires, poles, cables and instruments, which go to make its plant. It has a business, and the establishment of that business has cost millions of dollars. People who use the telegraph naturally turn to Western Union, unless they have some special reason for doing otherwise, knowing that if any point in the United States can be reached by telegraph at all the Western Union certainly goes there. This idea which is in the public mind—this "good-will," so to speak—is worth quite as much to the Western Union as its visible plant, and there is no reason whatever why it should not have a fair representation in the capitalization.

There is another invisible asset of the Western Union whose value is enormous, although it cannot be exactly determined. We refer to its contracts with pretty much all the important railroads of the country. To be sure, the railroads get a valuable consideration for the concession; but, on the other hand, that concession being practically exclusive, and at the same time tending greatly to economy in maintenance and administration, the consideration is, comparatively speaking, small.

The main point is, however, that competing companies cannot get such concessions. They must run their lines along country roads, and be at great expense for maintenance. Just as it was noted in England many years ago that the large rivers pretty much all ran through the large towns, so it has been observed in this country that pretty much all important business communities are on the trunk lines of railway, and these are reached by the Western Union in the most direct and economical manner. These contracts, then, are a very valuable asset to the Western Union Telegraph Company. They are as much a part of their profit-earning property as their wires and poles, and there is no reason why they should not have adequate representation in the capital stock.

It is something with a telegraph company, depending for its support upon the patronage of the public, as it is with a well-established newspaper. To reckon the value of a profitable daily at the cost of its type, presses and fixtures would be absurd. In fact, you may burn down the building in which any such paper is published, destroy absolutely everything which it contains, and still *the paper* remains; it still belongs to those who published it, and, if they do not care to continue it, they can sell it, although invisible and intangible, for more than the value of the visible property destroyed.

We are glad to see competition in the telegraph field, and believe that it will be a benefit to everybody, including the Western Union Company, but we are inclined to think that those who argue that a duplication of the Western Union's lines is in every case possible, or that, if possible, would result in taking away the Western Union's business, are very much in error.

## *ELECTRIC MOTORS AND THE ARCADE RAILWAY.*

The Broadway arcade railway bill, although it passed both houses, was for good reasons vetoed by the Governor. The principal objections to this scheme, urged in years gone by, were that the smoke from the locomotives would blacken the fronts of the buildings on either side of Broadway. This year another objection has been raised, and this, if based upon sound engineering principles, would in itself be sufficient to condemn the scheme. It has been alleged that the sub-strata of Broadway is composed of sand and that should the center of the street be removed, as would be necessitated in the plans proposed, the safety of the massive structures on either hand would be seriously threatened. Experienced engineers, however, have told us that these fears were groundless; that the substructure that would be required to insure the durability of the underground railroad would prove a far greater safeguard to the buildings than the sand displaced.

This removes the chief objection to the arcade railroad, and if the plans of the projectors will be sufficiently changed to permit of the use of electric motors instead of locomotives, the other obstacle in the path of the enterprise may also be forced aside.

We can readily understand that the owners of the costly structures on Broadway should protest against an arcade railway if a continuous cloud of carboniferous smoke is to issue from its openings.

In London, the circumstances for the atmosphere is naturally murky, the air is almost at all times filled with smoke, and every structure is more or less smirched with it. Fortunately for us, however, we have an altogether different climate, and it is possible to keep even a white marble facing comparatively clean. Now, the use of electric motors in the underground road would do nothing whatever to smirch the buildings along the route, for no fuel whatever would be required. Again, there is reason to believe that an electric railway is far more economical than the ordinary steam railway, besides being far more convenient.

Before deciding, however, upon which of the two general systems for propelling cars by electricity is the most desirable for the road in contemplation, the projectors should carefully examine each. In one of these systems storage batteries are carried by the car, and actuate a motor connected mechanically to the driving wheels. In the other the necessary electrical energy is transmitted to the motor by the rails of the track, or by an auxiliary conductor. Each system, it must be said, has its virtues and disadvantages. In the former method the principal disadvantages are the great weight of the storage batteries, and the fact that they return only a fraction of the power stored in them. In the latter system, the principal disadvantage arises from the fact of the unavoidable loss in transmitting the energy along the rails, both by leakage and by heating them. The results already secured with electric railways, however, are such as to lead to the hope of their ultimate adoption in practice. The fact that steam railway locomotives are far from economical, and that an electric motor makes no smoke and little noise, and that it weighs much less, and therefore requires less power for its propulsion and exerts less wear and tear upon the rails, furnish the principal arguments in favor of electric railways, and to these must be added the additional arguments that since electric motors can be made very small, simple and light, one can operate each car so that any number of cars can be run independently.

These cars are, too, so light that they may be started and stopped with great readiness, and this reduces both the danger of collision and the disastrous effects of collision should one occur. The impact of two of these light cars would, naturally enough, occasion less disorder and injury than the meeting of two powerful trains filled with combustible material and carrying a furnace.

So far as underground travel is concerned, electricity may be used where the steam locomotive could not be admitted. This has been proved in the mines of Lankerode, where is an electric railway in operation.

In the form of electric railway, which is favorably considered by so good an authority as the Siemens Brothers, and of which they have constructed several, all of which are now running, the current is transmitted from the dynamo along the roof of the tunnel through an inverted T-rail, upon which slides a contact-carriage connected to the motor on the car by a flexible conductor. The return current coming from the dynamo is taken to a similar inverted T-iron parallel to the first which acts as the return conductor. The reason for using separate conductors for both direct and return current is that the track is of necessity so roughly made that its electrical conductivity is small and its insulation poor. The motor, a Siemens machine, is placed lengthwise upon the car, and through suitable gearing turns the driving wheels which propel it.

One, if not the principal, reason why this description of motor has been devised is that the powerful currents required to move the cars may be placed out of reach of the public. But in an arcade railway, like that proposed, so expensive a system would not be required. The third rail system, there is reason to believe, will be found the most economical. The third rail or conductor used in this system lies in a large trough running between the rails, and over the trough is laid a cover along which runs a slit.

On the conductor rests a contact-carriage, kept in good electrical connection with it by both rollers and brushes. A strong metal plate attached to the contact carriage extends up through the slit; to this plate the car is connected and by it the current passes to the motor. After leaving the motor, the current passes to the uninsulated rails and thence back to the machine.

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If an invention has not been patented in the United States for more than one year, it may still be patented in Canada. Cost for Canadian patent, $40. Various other foreign patents may also be obtained.

### The Bennett-Mackey Cable.

At early dawn on Thursday of last week, May 22d, the steamer Faraday was sighted by the lookout on Thatcher's Island, and the news was speedily signaled to the village of Rockport, which lies out on the very knuckles of Cape Ann. The little town had been in a tremor of excitement for several days, and when at last the bells were rung to tell the news, the inhabitants rose as one man and started for the beach. By eleven o'clock the Faraday was at anchor within half a mile of the shore. The cable for the shore end was stored on the forward tank. It was slowly uncoiled and run out over heavy wheels to the stern of the ship, where it went over another wheel and was coiled upon four rafts. These rafts carried about four thousand feet of the cable, and when it had been safely coiled upon them the four were made fast to each other, and then boats crews were sent ashore with a heavy rope, the other end of which was fast to the first raft. The rope was brought safely ashore, and then a line of men began hauling on it. This brought the rafts towards the shore, and as they approached it the cable was paid out and sank to the bottom. At length the end of the cable was brought ashore and made fast near the cable house, a neat little cottage built for the purpose. The cable had previously been laid from Dover Bay in Nova Scotia to a point about 250 miles from Rockport, and there it was cut and buoyed. After safely landing the shore end at Rockport the steamer, paying out the cable as she went, started back for the buoy, where she spliced the cable, thus completing the connection between Dover Bay and Rockport. The next step is to steam to thirty miles east of Dover Bay, there to take up and splice the shore end already laid, and then to sail away for Ireland, paying out her cable as she goes.

The cable used in the present enterprise is undoubtedly the best that has ever been made, representing the accumulated experience gained in the construction of all previous ocean cables. It was manufactured by the Messrs. Siemens at their works near London. Upward of 2,500 men are employed in the establishment, and 1700 of these were employed on the present cables, for there are two of them, two to extend side by side from Ireland to Nova Scotia, whence one goes to Rockport and the other round Cape Cod to Fire Island, and thence to New York. The aggregate length of the two is over six thousand miles. The shore ends are two and one-half inches in diameter, while the cable proper is but one inch in diameter. The conductor is formed of thirteen wire, consisting of twelve small wires coiled around a central wire one-tenth of an inch in diameter. The insulating material is gutta percha, between which and the armor there is a cushion of jute.

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### The Paris International Electrical Conference.

The conference for fixing an international system of electrical units met in Paris on the 28th ultimo. The first meeting was held in October, 1882, and adjourned in order to give time for further experiments to be made. The following countries all sent delegates to the meeting:

Austria, Argentine Republic, Belgium, China, Costa Rica, Colombia, England, France, Germany, Holland, Guatemala, Italy, Japan, Mexico, Nicaragua, Persia, Portugal, Roumania, Russia, Salvador, Sweden and Norway, Switzerland, and the United States of America, making in all a total of some 53 members. England was represented by the following delegates named by the Government: Sir William Thomson, F. R. S.; Professor Carey Foster, F. R. S.; Professor Fleeming Jenkin, F. R. S.; Prof. Hughes, F. R. S.; Mr. Graves, chief engineer post-office telegraphs; Mr. W. H. Preece, F. R. S., chief electrician post-office telegraphs; Captain Abney, R. E., F. R. S.; Professor W. G. Adams, F. R. S; and Mr. J. Aylmer, C. E., the latter also acting as the hon. secretary to the British delegates.

The meeting was held at the Ministry of Foreign Affairs, M. Jules Ferry, President of Council of Ministers, and Minister of Foreign Affairs, presiding, and making the opening speech, in which he expressed the gratification felt by France in again welcoming the men of science sent by all countries to the conference. He referred to those members who had died since the last meeting: Sir W. Siemens, of England; Captain Hoffmeyer, of Denmark; and more especially Monsieur J. B. Dumas, of France; and finished a most effective discourse with the following words: "Happily, gentlemen, science is immortal, its light passes from hand to hand and never goes out. Inheritors of the researches of those great men who have gone before you, you gather in the fruit of their labor, and in your turn enlarge the domain of their peaceful conquests. This is, gentlemen, your special and enviable privilege, for while all the other works of man in public as well as in private life, have only a short duration, and only fulfil a transitory office, you alone are engaged on a permanent work, on the only human labor which never perishes, and which never ceases to extend."

The active presidency of the conference was voted to M. Cochery, Minister of Posts and Telegraphs, and three commissions were then formed, one for examining the question of electrical units, one for that of earth currents and lightning protectors, and one for fixing a unit of light. Several meetings of these commissions, and also of the full conference, were held, at which most interesting discussions took place upon the various subjects submitted for examination. The following resolutions were unanimously adopted:—

*Electrical Units Properly so Called*—Resolutions. 1. The legal ohm is the resistance of a column of mercury a square millimeter in section and 106 centimers long at the temperature of melting ice. 2. The Conference expresses the desire that the French Government will transmit this resolution to the various countries, and recommends its international adoption. 3. The Conference recommends the construction of primary mercury standards in conformity to the resolution previously adopted, and concurrently the employment of secondary scales of resistance, made of solid metal alloy, which shall be frequently compared with each other and with the primary standard. 4. The ampere is the current of which the absolute measurement is $10^1$ in electromagnetic units. 5. The volt is the electromotive force which maintains a current of one ampere in a conductor whose resistance is the legal ohm.

2. *Earth Currents and Lightning Conductors*—Resolutions. 1. It is desirable that the results of observations obtained by various administrations be sent each year to the Bureau International des Administrations Télégraphiques à Berne, who will make a copy, and communicate it to the Governments. 2. The Conference expressed the desire that observations of earth currents be pursued in every country.

3. *Standard of Light*—Resolution. The unit of each simple light is the quantity of light of the same kind emitted in the normal direction by a square centimeter of surface of molten platinum at the temperature of solidification. The practical unit of white light is the quantity of light emitted normally by the same source. The final meeting of the conference was held on the 10th inst.

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### A Standard Thermopile.

Dr. G. Gore, F. R. S., has invented an improved thermopile for measuring small electromotive forces. It consists of about 300 pairs of horizontal, slender, parallel wires of iron and German silver, the former being covered with cotton. They are mounted on a wooden frame. About 1½ inch of the opposite ends of the wires are bent downwards to a vertical position to enable them to dip into liquids at different temperatures contained in long narrow troughs; the liquids being non-conductors, such as melted paraffin for the hot junctions, and the non-volatile petroleum, known as thin machinery oil. The electromotive force obtained varies with the temperature; a pile of 295 pairs having a resistance of 95.6 ohms at 16 deg. Cent., gave with a difference of temperature of 100 deg. Cent., an electromotive force of .7729 volts, or with 130 deg. Cent. an electromotive force of 1.005 volt. Each element, therefore, equalled .0000262 volt for each degree Cent. difference of temperature. On having been verified with a standard voltaic cell the apparatus becomes itself a standard, especially for small electromotive forces. It is capable of measuring the $\frac{1}{10000}$ part of a volt. For higher electromotive forces than a volt, several of these piles would have to be connected in series. The fractional electromotive force is obtained by means of a sliding contact which cuts out so many pairs as is required.—*Engineering.*

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### Progress in Electric Lighting in Hartford.

Hartford has at last awakened to the new era in street lighting. After much opposition in both boards of the city government, a resolution was passed giving the electric light company power to replace gas-lights on some of the principal streets with their lights. They have placed in circuit up to the present time some 30 arc lights, taking the place of 195 gas-lights.

The change is wonderful in some sections of the city, especially in some of the lower wards, where the street corners have been infested by gangs of loafers and rowdies, who have been driven from their haunts, making streets that heretofore have been almost impassable for ladies as safe as broad daylight.

Your reporter visited the light station tonight, and was courteously received by Mr. A. Thatcher Pinkham, of Boston, the electrician of the company for the past six months. At the station there are five 25-light machines in circuit, driven by three Armington & Sims' engines of 50 horse-power. At the present time they are burning 110 lights, being within 15 of their full capacity. The light has come into general use in stores and hotels in this city, and has gained a footing so strong that gas can never displace it. The gas company has gone so far even as to remove their burners from the street lights, where the electric light has taken their place. Petitions have already been handed in for the street-lighting of sections of the city where the lights are not now in use, and it is to be hoped that in a short time Hartford will be thoroughly lighted by the only proper light—electricity. Very little trouble is experienced from the lamps. The circuits are so run as to in no way interfere with the telephone circuits, which is one thing that Hartford, above many other cities, has the advantage.

The officers of the company are: Colonel French, who holds the office of vice-president and general manager, and who is now gone on a visit to Colorado on private business; Mr. Frank French, his son, superintendent; A. T. Pinkham, electrician.

Hartford will soon be well represented in the field of electric lighting, being the home of two electric light manufacturers, whose business is not yet fully developed, but who will soon be in a condition to take the field in competition to the companies already established.

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The Boston *Saturday Evening Gazette* has a bright contributor who signs himself "Howe Merry"—rather a taking *nom de plume*, by the way—who has been the victim of some inventive person of vivid imagination. Hear the Merry tale: "There is one man, who lives not far from Boylston Street, who has a way of his own for settling all such little trifles. A little while ago there was put up a marching line of poles adown his short street, laced together with several strings of wires that whistled o' nights when the wind blew between them, and disturbed his sleep. He knows how useless 'twill be to go to the public authorities, so he devises a scheme of his own. He gets a long pole and a sponge and a big bottle of very strong acid. With the pole and the sponge and the acid he rubs those wires every night as he goes to bed. Three or four days—they drop in two pieces. They are mended. Three or four days, and the new ones drop. This is his line of action for several weeks. At the end of that time the telegraph company think this street is some way very unhealthy, and the climate very trying, if a copper wire cannot exist there, and the long line is removed." Now, if "Howe Merry" can tell us what telegraph company in Boston uses copper wires strung on poles, and what kind of "strong acids," being applied to copper wire once a day with a sponge for three or four days will disintegrate and destroy it, we shall be on a footing where we can begin to believe this Merry yarn.

## Telephonic News

*** Governor Cleveland did not lack for means of getting exact information touching the underground bill. A small army of telephone officials waited upon him in Albany on Thursday of last week.

*** Senator Daly says, in regard to the recent bill passed by the Legislature in reference to placing the wires underground, that the telegraph and telephone properties are not destroyed by his bill—they are only transferred.

*** The net output of telephones by the American Bell Company for the month ending May 20 was 5,023, against 6,763 in the corresponding month last year. It must be remembered that a year ago at this time the Lowell Syndicate was extending the telephone business very rapidly, and that there was an exceptional output of instruments.

*** The depression in the general market has not been without its effect on telephone securities, but it has in no way affected their intrinsic value. Those who owned them on margins have had to bleed a little, but those who own them outright have no occasion to trouble themselves about the present market price. The property is there, and capacity to earn dividends is unchanged.

*** A young lady of Birmingham, Ala., was about to marry a young man of Talladega, and it was to be on the strict quiet. When the bridegroom arrived at his Birmingham hotel, the bride-to-be seized the telephone to tell him she was ready and willing. Unfortunately, the telephone got mixed, and landed her message in the midst of a fashionable boarding-house of that city. Of course that gave the affair away, for in ten minutes all the town knew of it. Happily, the wedding came off all the same.

*** The report of the directors of the River Plate Telephone and Electric Light Company, Limited, for the year ending January 31, states that on that date the number of paying exchange and private wire subscribers in Buenos Ayres and Montevideo was 1,573, the annual value of the rentals being about $135,000, showing an increase for the year of 573, or 57 per cent., in the total number of paying subscribers, and an increase of $50,000, or 59 per cent, in the total annual value of rentals.

*** In one of the last sittings of the Société Scientifique de Bruxelles, M. de Locht, engineer, of Liege, presented to the members of the society the apparatus recently invented by him, and called the hammer telephone. The telephone differs from the Bell telephone in this respect, that while Professor Bell reproduced the word by the inflexions of a very small disc of iron and steel, the Liege scientist makes a wooden block, a piece of glass, of metal or india-rubber speak. These organs are inflexible. The experiments made by M. de Locht at the Société Scientifique were very satisfactory.

*** A new telegraph enterprise has been inaugurated in Gloucester, Mass., which those who are at work upon the lines call the New England Telegraph Company. The commencement was made in Essex, at which point a number of cars of telegraph poles have been received, and the town has granted the privilege of building the line within its limits. This enterprise has been inaugurated on account of the immense telegraphic business at this point, and prospective business of the American Bennett-Mackey Commercial Cable Company, with which it is to connect at Rockport. This is the sixth company that has built lines to Gloucester, as follows: Franklin, International, Atlantic and Pacific, American Union and Mutual Union, all of which have been absorbed by the Gould monopoly. At the present time there are eight telegraph and two telephone wires in constant use between Gloucester and Boston.

### The Providence Telephone Company's Report.

In addition to the general statistics of the business done by this company, which we published in our last edition, we give a synopsis herewith of General Manager Duxbury's report in detail, which will be of interest to our readers. It shows that the number of subscribers on May 13, 1884, was 2812, an increase of 409 from the previous year, when it was 2,403. There were at the time of the report fifty unfilled applications, and they continue to come in daily, and the indications are that as many telephones will be put in this year as in any during the history of the company. There were 214 instruments taken out during the year, owing to failure in business, death, removal and refusal to pay. Sixty-four of the above were summer connections, which will probably be replaced this season. The locations of 230 instruments have been changed during the year. The Superintendent says the work of fitting the central office with new switches has been completed, and the entire machinery is now adapted to an expansion of probably four thousand subscribers in one operating room with no further expense than the addition of the necessary switches to correspond to the increase in the number of subscribers. There are in the Providence Exchange the largest number of subscribers connected in one office of any with which the Superintendent was familiar, and he said the service will compare favorably with that of any system in existence. There are, and must be, delays and failures, and they will be more numerous as the lines and subscribers are increased. After speaking of some of the causes of delay, Mr. Duxbury's report says on the whole the service is in good condition, and all means will be used to keep it up to the standard. The operating room is so much crowded that in a short time it will be necessary to take measures to provide more room for the new switchboards which will be added this year. The Pawtucket and westerly exchanges have been entirely refitted with new switches; the office at Attleboro' has been changed into a new building, and the office at North Attleboro' has been refitted. The two last-named offices are maintained at a larger expense than the Superintendent thinks is warranted, and he was in the hope of making such arrangement as would reduce the cost.

The company has now nearly 1,900 miles of wire in use. He had rebuilt with substantial poles the lines extending from Butler Exchange to the office in Olneyville, and through Dyer and Eddy Streets and Potter's Avenue.

The gratuitous service between our exchanges burdens the company with a much larger proportionate expense than any company of which the Superintendent is informed. The free use of the long lines compels the maintenance of double the number of lines and several more operators than would be required for the work were a tariff charged for inter-town connections. Speaking of the underground system, Mr. Duxbury says there is still considerable agitation on the subject, but none has yet been found which is reliable for telephone purposes. The systems in Boston, Pittsburgh, Philadelphia, and Chicago, he understood, were not working in the way in which it was claimed they would. The agency for telephones and private wires under the American Bell Company's patents continues to be a source of profit. There are now 632 instruments leased for use on private wires. The messenger department continues to be lucrative and enables the company to collect the thousands of small accounts for ex-territorial connections with very slight expense. In conclusion the report says: "Our relations with the various city and town governments and property owners are amicable, and I apprehend no serious trouble in the way of extension of our lines as may be necessary.

The report was received and placed on file. The Finance Committee reported that the General Assembly had granted an amendment to the charter of the company, allowing it to increase its capital stock to $300,000. The Board of Directors were then authorized to increase the capital stock from time to time as needed, the stockholders to have the option of purchasing before it was offered to the public. The following-named gentlemen were unanimously re elected as directors for the ensuing year: Henry Howard, Henry G. Russel, Henry C. Cranston, R. G. Hazard, 2d, F. H. Peckham, Jr., R. M. Larned, Jas. H Chace, H. F. Barrows, C. R. Greene, J. U. Starkweather. The meeting then adjourned.

At the Directors meeting, which was held subsequently, the following-named officers were elected unanimously:

President—Henry Howard.

Vice President—Henry C. Cranston.

Secretary and Treasurer—Charles T. Howard.

Assistant Treasurer—H. H. Harris.

General Manager and Superintendent—J. W. Duxbury.

Assistant Superintendents—J. H. Clark, A. C. White.

The report of the result of the experiment of Thomas D. Lockwood, electrical expert of the American Bell Telephone Company, in regard to the Delaney Multiplex telegraph system, was read, and the closing paragraph of the report is as follows:

"When we remove the telephone coil from the immediate proximity to the other coil, the noise, of course, diminished, and even holding at two feet from the Delaney coil did not remove the noise altogether, and I think if any of these multiple telegraph wires are strung on one side of the street for a mile, and telephone wires on the other, we should still hear the noise, due to the currents induced by the Delaney system over anything else in the telephone."

### In Regard to Placing Telephone Wires Underground.

The bill to force electric and other wires underground, introduced by Senator Daly into the New York Legislature, having passed the Senate and Assembly, is now under the consideration of Governor Cleveland, and it is probable that before this communication is printed will have been either signed or vetoed.

It is not thought, therefore, that any statements herein contained can affect the subject one way or another. Since, however, the same subject will surely become, sooner or later, a prominent one in other localities, it is hoped that the considerations now presented will aid telephone men in forming conclusions, and in presenting them when called upon so to do.

The said bill provides that electric and other wires and cables shall be placed below the surface of the earth before November, 1885, in cities of 500,000 inhabitants and over. It is an example of the willingness of legislators to interfere with matters which they do not understand.

A distinguished senator comes forward and states that the thing can be done, and that such an eminent electrician as Mr. Edison says so; therefore, the only reason that corporations engaged in the prosecution of electrical enterprises do not take action in the matter is because they are afraid of the expense. This position is scarcely a logical one in view of the fact that one great company, at least, has made a bold and expensive attempt to overcome the obstacles, electrical and mechanical, that obstructed the way, and has also ignored the expense, and laid a substantial experimental subterranean telephonic system in the streets of Boston.

It is a curious but none the less an actual fact, that, although patented inventions on the subject of underground conductors have been without stint, the majority of them have been directed either to improvements in insulation, or to mechanical arrangements. Insulation, of course, must be maintained, and is an absolute essential in underground systems; but in these days of first-class guttapercha, India rubber, kerite, and paraffin, it is not by any means extremely difficult of attainment.

I have, however, very little faith in coal tar, pitch, or bitumen, as they have very little insulating power, and the durability of wires embedded in them is at best doubtful.

But insulation is almost altogether a question of degree, inasmuch as an insulation which is apparently impervious to a low tension current, appears to conduct very fairly a telephonic current or induced currents of high potential. It has also been ascertained by actual experiment that an infinitely great resistance is not required in telephony, but is rather detrimental, and tends to intensify the retarding and prolonging effects of static induction.

People are very frequently heard to say, when referring to this subject, that we make "induction" an excuse for all our shortcomings. If we are asked why we don't bury our wires, the answer is "Induction." Why don't your operators answer calls more promptly? "Induction." Why are your lines out of order so frequently? Well, again, "Induction." And there is no doubt that, with one exception, the unfortunate "Hello," induction is the best abused word in the telephonic vocabulary.

And yet it is an idea not hard to comprehend when we set our minds to it.

Even among our own telephone men, I am afraid that many would consider it news to be told that induction helps them fully as much as it hinders them—rather more, if anything. That they could scarcely talk plainly over a line 100 yards long, were it not for induction. How is that? they will say. Why, simply between the primary and secondary coils of the Blake transmitter. Nor is this all. Why is it that, by simply turning a handle we can ring a bell many miles away, or cause the drop of an annunciator to fall and give a signal when we desire to invoke the sweet ministrations of the young lady who presides at the switchboard. Why? Because magneto-electric induction steps in and enables us, by passing a coil of wire quickly in front of a magnet, to develop electric currents in the said coil, which currents, passing over the line, charge the electro-magnets of the annunciator or bell, and give the signal. Why is it that, when we want to neutralize the return discharge in a duplex or quadruplex system, we loop a condenser round the balancing resistance? Because, by utilizing static induction, we can collect a charge in the condenser of opposite character to that in the line, which, discharging at the same time the line discharges, neutralizes the deleterious effect. We thus see that "*induction*" in several forms may be utilized to our advantage. Like fire, it is a good servant, but a bad master. And no matter what the scoffer may say—and only those scoff at induction who know nothing about it—the several difficulties which stand in the way of good telephonic service as administered over underground lines may be stated in the following order:

*First*—Static induction, as exhibited by the effects of running the words together, and in some cases, where the lines are long or switched on to a long overhead line, the conversation seems to be altogether suppressed. Although this phenomenon was at first scarcely anticipated in telephony, it might have been if proper thought had been given to the subject.

*Second*—Dynamic induction. The fruits of this vine are so well known that it is scarcely necessary to enumerate them. The repetition of signals between one line and another, so that subscribers belonging to one line hear what is going on in others perfectly well; or, if a telegraph line is stretched parallel to a telephone line, the telegraphic signals may be clearly distinguished by listening at the telephones.

*Third*—The mechanical difficulties in the way. These comprise the nuisance of digging up the streets, of finding *room* in the streets amid the labyrinthine intricacies of gas, water, steam, and sewer pipes; of finding an entrance into the various subscribers' stations, and last, but not least, the problem of finding a practicable way from the central station into the conduits.

*Fourth*—The difficulty of maintaining insulation, which is greater than might be expected, since even in corner vaults, working chambers, and manholes it is essential that every wire must be perfectly covered with some durable insulator.

*Fifth*—The expense. This latter item need not be enlarged upon, as every one can understand it. It will be noticed, however, that expense is the last item which I have mentioned, as being the most inconsiderable. Inconsiderable, however, as it may be in relation to the other opposing influences which I have enumerated, it is by no means inconsiderable when viewed alone, it being calculated by the highest authorities that the cost of constructing a first-class underground system is approximately four times that of a similar system overhead. On the other hand, we cannot disguise from ourselves that subterranean lines possess an immunity from damage due to elemental war and from atmospheric troubles, which no pole line, however well built, can possibly have.

It is chiefly this latter consideration which has induced telephone companies to seek a way whereby wires may be laid beneath the surface of the earth without impairing the service. Those who are willing to consider the subject impartially can scarcely doubt that such is the case. Whatever the faults may be which are chargeable against the managers of telephone companies, their most outspoken enemies have never charged them with a lack of foresight and business enterprise. And in view of the wholesale destruction of overhead lines during the sleet storms of the spring, it would seem reasonable so to charge them, were there any practical way of burying wires which was not immediately adopted, or at all events fairly tried. The expense therefore, heavy though it be, would be cheerfully borne if a reasonable expectation of good and durable service could be indulged in.

The mechanical difficulties need scarcely be discussed here, as the conditions differ so greatly for different cities; but in the city of New York they are so multiplied by the densely populated condition of the earth below the surface—several systems of gas-pipe, the city water-pipes, a system af steam-pipe, a system of sewerage, and in some districts a system of pneumatic tubes, being already there.

It is thus evident that only one plan can be successfully adopted in New York—namely, the subway method which obtains in Paris.

If continuous vaults could be provided, spacious enough for all the conduits and systems of tubing required by the multifarious wants of our modern civilization, we might hope to successfully combat the many obstacles which now stand in the way and oppose all advances towards underground conducting wires.

The difficulties of maintaining insulation need not be further discussed here, as the cables now made by the principal manufacturers are certainly as perfect in that direction as they can well be made, and it is therefore only at joints and connections where trouble is likely to ensue.

The choice of careful, painstaking, and intelligent workmen, who understand the value of perfection in every little detail, will do much to prevent trouble at these points; and employers will do well to remember that such men cannot be obtained without the payment of good wages.

It remains for us to consider the electrical difficulties of dynamic and static induction, with their Pandora's box of complications.

We all know that even when telephone wires are strung on poles and cross-arms, with a good ten inches between any two, we can often distinguish conversations which we know are being carried on over another wire.

Telephone men who have been blessed, or cursed, with a telegraphic apprenticeship, can all testify that they have, while listening to telephones, read messages which have been at the time in the act of transmission by Morse on other wires.

Those of us who have the constantly varying rush of the induced currents caused by the proximity of electric light wires, are not likely to forget it.

It may readily be conceived that if lines can so act and react on one another, when strung a considerable distance apart, sometimes the width of a railroad, that these effects are much greater when the lines are only separated from one another by two thicknesses of ordinary insulation. And such is the case. It has been found by actual experiment that, when two insulated wires are laid parallel for a distance of only a few hundred feet, the induction between them is so great that it is difficult to tell whether the wires are actually crossed or not. Many remedies have been proposed for this. One of the most popular methods has been to surround each insulated conductor with a metal sheath connected at different points to the ground. For short distances this has proved to be moderately effectual, but at the cost of distinct articulation.

Lately it has been proposed to insulate in turn the metallic sheaths, and to connect them together in pairs, so as to form a complete closed circuit for the induced currents.

But the only radical remedy is one which has been known for many years, and which was patented long ago in England by Dr. Werner Siemens; this remedy is the metallic circuit, consisting of two wires, the outgoing and incoming wires of the circuit placed nearer to one another than to any other wires, so that any extraneous conductor, acting inductively upon the said metallic circuit, will act upon both wires at once, and generate opposing currents in them, which currents will neutralize one another, leaving the circuit practically free from any disturbance whatsoever.

This plan attains its highest degree of efficiency when the two wires of the metallic circuit are twisted together.

If the disturbing element of dynamic induction were the only one, we can now see that by utilizing the double conductor we could conquer it, albeit at great cost and inconvenience. Cost, because the remedy means a complete duplication of every foot of wire used; inconvenience, because it is by no means so easy to arrange calling and switching mechanicism for metallic circuits as it is for grounded circuits, and because their general adoption would necessitate an almost complete reorganization of the exchange systems and apparatus now in use.

The disturbances due to electro-static induction have as yet scarcely been touched upon. Of late years we have been accustomed to hear much of "retardation;" and experts, who ought to know better, have talked of "induction" and "retardation" as if they were twin causes of electrical trouble and annoyance.

It is about as sensible as if we should call water "drowning," because a prolonged stay under water will achieve that result.

Retardation of electric signals is one of the results of electro-static induction, and, if we may say it, one of the most depraved results that it is possible to imagine.

Electricity can only rest on a conductor when that conductor is properly insulated, or when it is held there by a corresponding charge of electricity of the opposite character. The latter condition comes into play in the case of the under-ground conductor. If we take a Leyden jar (which, as every one knows, consists of a glass jar coated both inside and out with tinfoil), and set it on a block of ebonite or paraffin, so that the outer coating is completely insulated from the earth, we shall find that it will scarcely take any charge of electricity at all from the electric machine. If, now, we connect the outer coating with the earth, or with some conductor in contact with the earth, we shall find that the jar is capable of receiving a heavy charge, its capacity having been indefinitely enlarged, inasmuch as the earth connection is actually equivalent to increasing the size of the outer coating indefinitely.

Now, while an insulated underground wire does not present an exact equivalent of a Leyden jar, inasmuch as it is connected at the ends (if an earth-circuit wire) with the earth, still there is considerable resistance to pass before the ground is reached, and that gives a fairly large capacity.

One of the oldest and well-known methods adopted in cable signaling, to reduce the retarding and prolonging effect of signals, was to send a short pulsation of reversed character to neutralize the charge. This does not, however, work in telephony. The telephonic current most generally used is an induced current, and is in reality being reversed continually; but as the pulsations and change is wonderfully rapid, and must correspond to the voice changes, which vary some thousand times per second, one pulsation follows another so fast as to virtually neutralize it before any distance is reached or any work done. As a matter of fact, the changes occurring in telephony are so rapid, and the necessity for the changes of current to copy the changes in the sound waves is so great, that the slightest distortion is detrimental to the proper transmission of articular speech.

It has been found that speech may be electrically transmitted over short lines under ground, but that, when a long overhead line is attached to the said short line, it is almost impossible to work either way, but that it is more difficult to work from the long overhead line to the end of the underground line than *vice versa;* and this is what might be anticipated, for the long-line currents arriving are so enfeebled that they have not sufficient energy to overcome the retarding influence of the underground length. They, therefore, expend themselves in charging the underground conductor, whereas currents emanating at the station nearest to the underground length are fresh, and after charging the line have sufficient vitality to pass to the distant end.

I have no idea that the metallic circuit remedy is efficacious as a remedy against static induction, and the retardation resulting therefrom, because the conditions of the Leyden jar obtain still more strongly in this case than in the case of the ground circuit. Time and experiment only will enable us to comprehend the best conditions of underground telephonic working. But we know more about it now than we knew two years ago, and have more of an idea of the character of the difficulties in the way than we had then.

And we know that no amount of legislation performed in the capital of the State of New York can counteract the laws of nature.

All we can do with our present knowledge is to reduce its adverse effects, and there is every probability that a mixed system of overhead wires, aerial cables and underground cables can in many places be adopted with a reasonable amount of success.

Up to the present time the result of underground work is certainly not more than one-fourth as good as that performed on overhead work, while, as we have seen, the cost is over four times as high; so that, all things being equal, the commercial disabilities of the underground wires are sixteen times greater than the overhead wires.

THOS. D. LOCKWOOD.

..... The petition of the Baltimore & Ohio Telegraph Company for special facilities on the New York & New England Railroad has been dismissed by the Railroad Commissioners. The case grew out of the refusal by the railroad company to deliver poles, wires, etc., at points between stations, the telegraph company's location bordering upon that of the railroad. Mr. Clark, the receiver, bases his refusal on the terms of the contract existing between the railroad corporation and the Western Union Telegraph Company, and the commissioners hold that "the facilities asked for by the petitioners are not within the scope of the ordinary duties of railroad companies as common carriers. The rule is to deliver passengers and freight at stations established by the company. To entitle the petitioner to accommodation it must be shown either that the exceptions to this rule are so numerous that such delivery is to be regarded as a reasonable facility whenever it is conveniently desirable, and also that such a practice is safe, and not an unreasonable hindrance to general traffic; or it must be shown that the course of this railroad company has been such toward like applicants that the refusal in this case constitutes undue disadvantage."

The board holds that these requisites are not proven, and adds that even if the railroad company, with a view of securing telegraph facilities for its own advantage, should contract with one company to deliver its materials in the manner indicated, such a contract would establish no precedent for a second telegraph company, which could not in the nature of things offer a like advantage.

## TELEGRAPHIC

.... The Mutual District Messenger Company, of Boston, has declared a quarterly dividend of $2 per share, payable June 1.

.... A movement has been started in England for the establishment of a system of lower rates for night cable messages between England and the United States. The subject will be brought to the attention of Parliament at an early day.

.... The appeal of Hind *vs.* Russell and others, of London, in an action in which plaintiff claimed £100,000 as damages in respect of alleged injustice which he had suffered in connection with the United Kingdom Electric Telegraph Company, was dismissed by Mr. Justice Grove, on the 10th inst, with costs.

.... An influential public meeting has been held at St. Margaret's Hope, Orkney, when the amount required by the post-office for the extension of the telegraph to that island, and also to the island of Burray and the fishing station at Holm on the mainland, was subscribed by merchants, curers, and fishermen. The Fishery Board, it was stated, has agreed to give two-thirds of the guarantee, and now that the sum is subscribed it is expected that the extension will be proceeded with at once.

.... Some time ago the Portuguese, desiring to extend their trade relations with Macao, proposed to lay a submarine cable between that possession and Hong Kong. We now learn from Lisbon that the usual notice has appeared in the *Diario do Governo*, authorizing the Government to enter into a contract with the Eastern Extension, Australasia, and China Telegraph Company, for the laying and working of a cable between the two ports, joining the main system at Hong Kong.

.... "Telegraph operators are becoming more subject to pen-paralysis, or paralysis of the hand, every year as the work grows more laborious." Every man takes a just pride in sending out good copy, and when he is compelled to write through eight or ten sheets of manifold it is very tiresome on the hands. Various causes have been assigned for this affliction, some attributing it to the metal on the penholder, hence all kinds of devices have been gotten up and are in use to prevent this. It requires the best operators for press work, and as that is constantly on the increase the liability to be afflicted with paralysis is increased.

.... The managers of the several telegraph companies are already at work arranging for the work of handling the press business at Chicago during the convention week, and bidding for the patronage of the great dailies in all the large cities, who will be represented by from three to six correspondents each, and who will receive from 10,000 to 40,000 words each every day. This year the Western Union's principal competitor for the business of the Eastern press will be the Baltimore and Ohio, and that company will undoubtedly make a big effort to carry off the lion's share.

.... Annual meetings of the stockholders of the Pacific and Atlantic, Delaware River, and Continental Telegraph Companies were held May 20. The first-named company elected the following directors to serve during the year: Norvin Green, president; Thomas T. Eckert, C. A. Tinker, Henry Bentley, James Merrihew, and S. S. Garwood. The Delaware River Company elected directors as follows: Henry Bentley, president; C. A. Tinker, John Van Horne Rosewell, Rochester, S. S. Garwood, G. W. Porter, and James Merrihew. The Continental Company elected as directors: James Merrihew, president; Henry Bentley, C. A Tinker, S. S. Garwood, and G. W. Porter.

## ELECTRICAL AND SCIENTIFIC

* * It is said that a very careful and important determination of the electro-chemical equivalent of silver has been made at the Observatory of the Physical Institute of Wurzbourg, and the results are that an ampere current flowing for a second, or a coulomb of electricity, deposits 1.1183 milligrames of silver, or 0.3281 milligrammes of copper, and decomposes 0.09328 milligrammes of water—a result agreeing closely with that of Lord Rayleigh, recently communicated to the Physical Society. An ampere, therefore, deposits 4.0259 grams of silver per hour; Kohlrausch's value is 4.0824—a value hitherto accepted universally. This value is so useful in measuring electric currents with accuracy, and free from the disturbances of magnetism, etc., that it is eminently satisfactory to find the German value agree with that of Lord Rayleigh, which will probably be adopted by English electricians.

* * During the late Electrical Exhibition at Paris, a meteorograph, devised by the renowned Belgian electrician, M. F. Van Rysselberghe, and constructed by M. Schubart, of the University of Gand, was shown at work recording continuously, the barometrical, thermometrical and other readings shown by instruments in operation at the distant Observatory of Brussels. This apparatus was called a telemeteorograph, and its perfect action at such a great distance amply justified the choice of its name. It had already been in use at Brussels for three years, working without any interruption, and these two tests speak both for its ingenuity and for the skill and solidity of its construction. The instrument lightly engraves its record on a zinc cylinder, which, when covered with traces, has its lines deepened in an acid bath or in perchloride of iron. From this zinc plate any required number of impressions can be obtained. The meteorograph registers every ten minutes the height of the barometer, the temperatures of the dry and the wet thermometers, the amount of rainfall, and the direction and velocity of the wind. It thus records six different observations, and, if desired, may be constructed to take note of many more.

* * At a special meeting of the Electrical Section of the Franklin Institute, held at the end of March to consider in what way the section could best aid in promoting the International Electrical Exhibition, resolutions were adopted requesting the members of the section to indicate to its president the branches of electrical science with which they were most familiar, and in which they could be of most service in securing exhibits, and authorizing the president to appoint as many committees as he thought advisable, whose duty it should be, by individual action, to induce inventors and others to exhibit their instruments and devices. The committees have been appointed, and are now at work in their respective classes and localities.

SEC. 1. Classes 1, 2 and 3—Production of Electricity: Apparatus for electricity of high electromotive force, voltaic electric apparatus, thermo-electric apparatus. Messrs. A. E. Outerbridge (chairman), H. W. Sellers, D. S. Holman, Geo. H. Perkins.

SEC. 1. Classes 5 and 6. Dynamo-electric apparatus; mechanical motors—steam, gas, water, heat and wind engines. Messrs. W. W. Griscom (chairman), N. H. Edgerton, R. B. Haines.

SEC. 2. Electro Conductors. Class 5. Submarine cables. Messrs. W. J. Phillips (chairman), David Brooks, A. B. Burk.

SEC. 3. Measurements. Messrs. John W. Nystrom (chairman), Murray Bacon, A. F. Fleischmann.

SEC. 4. A. Apparatus requiring electric currents of comparatively low power. Messrs. Murray Bacon (chairman), L. H. Spellier, A. F. Fleischmann.

SEC. 4. B. Apparatus requiring electric currents of comparatively great power. Messrs. A. B. Burk (chairman), N. H. Edgerton, W. W. Griscom, A. E. Outerbridge, John Weaver.

(*Continuing from page 3.*)

pany's stock is now fully an eight per cent. investment.

In Hartford, Conn., a 100-light plant was put in during the summer of 1883, and, despite the bitterest opposition from the very powerful local gas company, the business has steadily increased. Within the past few weeks a contract has been secured from the city, after a long and acrimonious contest waged by the gas interest, for 30 street lights, which it is probable will speedily be increased to at least 100. The Hartford company, which has a capital of $100,000, is now operating 125 lights, and is putting in 75 more, which will bring it up to a full 200-light plant within a few weeks, and insure its profitable operation.

In Providence, R. I., a superior plant of 200 lights capacity was put in during last summer, and here also a severe fight was at once opened by the local company, operating a rival system. Not only were all legitimate means of opposition exhausted by the representatives of this rival company, but the most unwarrantable abuse of the president and other directors of your company, of the company itself, and of the Thomson-Houston system, were indulged in to prevent our gaining recognition at the hands of the city government. You have already learned with pleasure and satisfaction that not only did these efforts fail, both branches of the City Council unanimously granting to this company the rights asked for, but that as an outcome of this contest the city government of Providence has recently given a contract for 75 lights on the streets to our sub-company, the Narragansett, in place of 60 lights formerly run by the rival company. The Narragansett Company, which has a capital of $100,000, and which numbers among its directors some of the foremost business men of Providence, is now operating 125 lights, with a fair prospect of increasing to its full capacity before the close of the season.

The Consolidated Electric Light Company of Maine was organized in the city of Portland early in the past winter, with a capital of $500,000 authorized, of which only $200,000 has been issued. This company now owns lighting stations in Portland and at Old Orchard Beach, with another one at Saco and Biddeford contracted for. In Portland the local company operating the Arnoux system was bought out and consolidated with the company being formed by your management, the station building and land purchased, and a 200-light plant put in, of which 150 lights are now in profitable operation. Meantime, a rival lighting company in Portland, which, pursuing the tactics of those in Providence and elsewhere, bitterly assailed the system represented by your company and the personal character of its directors, has virtually gone to pieces, and, having lost nearly all its business, is being "reorganized," or wound up. Our business in Portland is growing steadily. A petition from a large number of the leading business men of the city for the introduction of our lights upon the streets has been granted by both branches of the City Council, and a contract has been awarded to the Consolidated Electric Light Company for the speedy placing of a number of electric lights on the street, and this in the face of the fact that the city of Portland is the owner of a large portion of the stock of the local gas company.

At Old Orchard Beach a plant of 100 lights was put in during last season, and the illumination of the railway station, the principal hotels, the skating rink, and the beach front itself added much to the enjoyment of thousands of visitors to this charming watering place. A suitable building was bought and fitted up for a lighting station here, and is one of the most convenient and best for its capacity to be found anywhere. The directors of the Consolidated Company include many of the wealthiest and foremost business men of Maine, and the prospects of this company are exceedingly flattering.

In Worcester, Mass., a 200-light plant was put in during last fall, which has been purchased by the Worcester Electric Light Company, organized with a capital of $100,000, and composed of the best and most prominent business men of the city, including a number of presidents and directors in banks, manufacturers and merchants, whose financial stability, integrity and business standing give them the confidence of the entire community. The Worcester central station was equipped, the plant put in, lines run, and lights started up within five weeks' time, and the entire outfit is pronounced by competent judges one of the most thoroughly built and perfect to be found in the country. The city of Worcester has placed some sixty of the company's lights upon the streets; contracts have been made for lighting the Union railway station, the skating rink, and most of the principal stores and hotels, and the company is now running over 175 lights, with a prospect of speedy increase. This company is not only one of the most solid, but one of the most profitable of the sub-companies formed under our auspices.

A new company, organized this spring, and called the Lewiston and Auburn Electric Light Company, has been formed to operate in the cities above named, with a capital of $60,000. Here, too, a strong board of directors, composed of leading business men of the two cities, has been secured, and a 100-light plant has been put in and paid for, and will probably soon be doubled.

At Cottage City, Mass., during the past season, a plant of 50 lights was successfully operated, and will this season be increased to 100 lights. This plant has not been transferred to a local organization, but is still owned by your company.

Work is in progress on a central lighting station to supply the city of Chelsea, and the two wards of Boston known as East Boston, where a 100-light plant is to be put in at once, with provisions for increasing to two or three hundred lights as required. Work has also been begun on a sub-station, for 50 lights at first and 100 lights ultimately, at Revere Beach. At both places land and buildings have been purchased, and it is believed that these stations can be very economically and profitably operated. There is a large demand for the lights in the places to be covered by the Union Electric Light and Power Company, which is now organizing with a capital of $100,000 to purchase this plant and do the lighting business in this territory. The stock of this company is largely taken, and it bids fair to be a most prosperous sub-company.

The Cambridge and Somerville Electric Light Company has been organized with a capital of $75,000, to operate in the cities named, and its stock is partly subscribed. A 100-light plant is projected for these places.

At Saratoga, N. Y., a company with $100,000 capital, nearly all subscribed, has been formed, and a 100-light plant is to be put in at once, with 100 to be added hereafter. Fully 100 lights have been subscribed for, and there is no doubt that this queen of summer resorts will be this summer more than ever attractive, when illuminated by the brilliancy of the Thomson-Houston lights.

It is worthy of mention that in every place, with the single exception of Hartford, Conn., where your company has established stations, complete plants have been constructed; boilers and engines, and in several cases the land and buildings as well, being owned by the companies. In Hartford alone steam is bought from a large steam-heating and power company, whose works adjoin our lighting station. In all other places our companies produce their own steam, and are thus enabled to obtain their power at minimum cost. This policy of ours is in gratifying contrast to that of most other parent electric companies, which usually buy their power wherever they can, frequently being obliged to run their machinery with engines entirely unsuited to the purpose, and to pay an exorbitant price for such service. Aside from the economy in operation which we gain, we secure by the use of the Jarvis furnaces, and Armington and Sims' high-speed engines, absolute evenness and steadiness of power, enabling us to produce a far better light, at much less cost than we could do by the use of power not specially designed and adapted to the purpose.

### CANADIAN BUSINESS.

In January of the present year, your directors purchased the entire business and property of the Thomson and Houston Electric Light Co. of Canada (limited), which had previously secured the rights for the entire Dominion for the Thomson-Houston system and had fully equipped a large factory in Montreal with the most approved machinery for the manufacture of dynamos, lamps, and other appliances for the business. This company through lack of capital and want of experience in its promoters, had failed to do a remunerative business and was glad to dispose of its valuable territory and property at a very low figure. After your company acquired this property, the business was pushed with energy, a 200-light plant was put in operation in Montreal, and smaller plants in Quebec, St. John, N. B., and Kingston, Ont. Meantime, a syndicate of wealthy capitalists was formed in Montreal, which has since purchased from this company at a large profit, the business, franchises, and property of our Canadian branch. A charter is now being taken out through the Quebec Legislature for the Royal Electric Company, which has been organized by the syndicate mentioned, to carry on the business throughout the Dominion.

### THE IMMEDIATE FUTURE.

Hitherto one of the chief expenses of operating an arc-lighting system has been the cost of carbons consumed in the lamps. Your directors are happy to announce that during the present spring, through the sharp competition between the companies which manufacture these carbons, successive reductions in the price have been secured, until now we are obtaining carbons at a little more than one-third the price paid a year and a half ago. In the meantime the quality of the carbons has been gradually raised, so that a much longer life is secured for the carbons and a better light is furnished.

The use of improved methods of combustion has also resulted in a large saving in the cost of fuel to generate steam for our engines. The result of these reductions means greater economy in production and consequent larger profits from lighting for the companies using our plants. Your directors now have under consideration the use of a new device which, it is believed, will reduce at least one-half the cost of producing steam. Experiments are in progress for testing the system alluded to, and the results thus far attained give promise that the results claimed by the inventor will be realized.

In the meantime a new contract has been made with the Thomson-Houston Electric Company, under whose license we operate, and whose dynamos and lamps we use, which promises in the near future to bring about a vast increase in this company's business. Hitherto, as you are aware, the concession from the Thomson-Houston Electric Company to the American Electric and Illuminating Company has covered the New England States, with the exception of a few places which had been ceded prior to our contract being made.

The new contract cedes to the American Electric and Illuminating Company full control of all the territory east of the Mississippi river, excepting the States of Illinois, Louisiana, Pennsylvania, Delaware and New Jersey. In Illinois and Louisiana as well as in the States west of the Mississippi, we are to operate jointly with the Thompson-Houston Electric Company. The great advantage to your company of this new concession cannot be over-estimated. Not only do we gain a vast and wealthy territory for the extension of our operations, but the terms given us by the Thomson-Houston Company in connection with the extension of area are so much more favorable than those which we have hitherto enjoyed that our margin of profit is largely increased, and we are enabled also to give better terms to our sub-companies, thereby rendering it easier to introduce our system and giving the sub-companies in their turn the opportunity for more profitable operation. The negotiations with the Thomson-Houston Electric Company which have led up to this result have been in progress for some months and have been marked by the utmost candor, fairness, and good feeling on both sides, and your directors believe that the outcome will prove mutually satisfactory and advantageous. Of course so vast an extension of territory will require a great amount of capital to enable us to promptly occupy the field and vigorously push the work of construction in it.

As has already been stated, the actual money capital of your company is represented by the 25,000 shares of preferred stock, for which ten dollars per share has been paid into the company's treasury. Our experience in the past, within circumscribed limits and under less favorable conditions than those which will attach to our extended business, amply prove the earning capacity of the company. Three semi-annual dividends, of four, six, and six per cent., respectively, have been paid upon the preferred stock, while the common stock, though not guaranteed any dividends and representing no actual cash received by the company, has received two semi-annual dividends of two per cent. each.

It is, therefore, no oversanguine or extravagant prediction that, under the advantages of our new contract with the Thomson-Houston Company and in the vast territory which we have secured, the company's net earnings will be sufficient to pay dividends as large as those already paid, on a very much larger capitalization than at present. Considering the amount of business already done and now in progress, the paid capital of this company is very small in comparison with that of other corporations engaged in similar work, and is altogether inadequate to permit any considerable extension. To construct and place in operation electric lighting plants requires the use of a large amount of money for a time, while the local lighting companies are being organized and before returns can be received from them for the purchase of plants. Your directors therefore believe that in order to gain the full benefit of increased profits from the augmented business of the company, and to permit the immediate construction of lighting plants in several important cities, from which demands have come for the introduction of our system, an increase of your capital should be authorized to a sufficient sum to provide for these prospective requirements. They therefore propose the passage of the following vote:

"*Voted*, That the authorized capital stock of the Company be increased by the addition of five hundred thousand ($500,000) dollars to the preferred stock of the company, and that said increase be issued and sold at not less than par, in such quantities and at such times as shall be ordered by vote of the directors, when required for the extension of the business of the company; any unissued balance to remain in the company's treasury."

This increase in the company's capital stock, your directors believe, can be placed

in such amounts from time to time as may be necessary to provide funds for extending our operations, and that handsome dividends can be earned on such stock as fast as issued, as well as upon the stock now outstanding.

Arrangements are nearly perfected for introducing an improved system of incandescent lighting in connection with our arc system. Prof. Elihu Thomson, the inventor and electrician of the Thomson-Houston Electric Company, has been busily and indefatigably at work on this system for some months, and his experiments have proved fully successful. The manufacture and introduction in practical use of the incandescent lamps is about to begin. We are also nearly ready to begin the use of electric motors, in connection with the station of the Merchants' Company in Boston, by which electric power can be transmitted for manufacturing purposes. The benefit of this power system will also be shortly extended to the other sub companies.

THE FINANCES OF THE COMPANY.

Your directors take pleasure in calling your special attention to the appended financial statement of your Treasurer. For a company which has a record of less than one and one-half years' active business, the showing it makes is eminently satisfactory and gratifying. After paying the abovementioned dividends on a cash capital of only $250,000, a surplus of $136,343.47 stands to the credit of the company, which affords a guarantee of value for the common stock. If so large earnings have been made upon the small amount of capital actually paid in, within a limited field and under circumstances more disadvantageous than any which we can fear will embarass our future operations, what may we not expect for the future, with increased capital, better facilities, and a territory as large as we can hope to properly improve within the next few years.

Congratulating you, therefore, upon the results already accomplished, and predicting for the future even greater success, your directors submit to you their annual report, and ask for the new board, to be chosen by you to-day, a continuation of the generous support and confidence which you have always so willingly accorded to us in the past. For the Board of Directors,

EDWARD H. GOFF, President.

Portland, Me., May 24, 1884.

STAETMENT OF ASSETS AND LIABILITIES APRIL 30, 1884.

| | | |
|---|---|---|
| *Assets.* | | |
| Due in cash from sub-companies secured by collaterals | $154,645 09 | |
| Stock in sub-companies constructed | 248,277 37 | |
| Bills and accounts receivable | 29,564 84 | |
| Due from sub-companies under organization | 971 60 | |
| Merchandise and plant | 15,921 22 | |
| Real estate in Portland $13,941 | | |
| Less due on same 11,000 | 2,941 00 | |
| Office furniture and fixtures at home office and sub-companies | 4,000 20 | |
| Cash on hand | 5,128 40 | |
| *Liabilities.* | | |
| Capital stock preferred | | $250,000 00 |
| Bills payable | | 9,823 20 |
| Accounts payable for construction, etc | | 35,282 85 |
| Due on purchase of Canada business, payable in monthly payments of $2,000 each | | 30,000 00 |
| Surplus | | 136,343 47 |
| | $461,449 52 | $461,449 52 |

H. E. IRVINE, Treasurer.

Boston, Mass, May 24, 1884.

ELECTION OF DIRECTORS.

The meeting, which was largely attended and very harmonious, voted unanimously to authorize the increase of the capital, as recommended by the directors, and elected the following-named gentlemen directors for the ensuing year: Silas Gurney, proprietor Tremont House, Boston; Loren N. Downs, general manager New England Telephone and Telegraph Company, Boston; H. S. Collins, banker, Collinsville, Conn.; H. P. Frost, general manager Southern New England Telephone Company, New Haven, Conn.; Edward H. Goff, Boston; Payson Tucker, general manager Eastern and Maine Central Railroads, Portland, Me.; Hon. Joseph R. Bodwell, president Hallowell Granite Company, Hallowell, Me.; Charles B. Whiting, banker, Worcester, Mass.; R. M. Kimball, special agent United States Treasury, Boston; Dr. J. G. Graves, Nashua, N. H; Henry Colony, treasurer Cheshire Mills, Keene, N. H.; H. E. Irvine, general manager the Royal Electric Company, Montreal, P. Q.; William E. Hodgkins of Charles A. Smith & Co., Boston. F. Montague Sowdon was elected treasurer and clerk, and Clarence Hale of Portland, assistant clerk. The following votes were passed:

Voted—That the thanks of the stockholders be hereby extended to Mr. H. E. Irvine, who, retiring from the office of treasurer of the company to assume the general management of the Royal Electric Company of Montreal, Canada, carries with him the best wishes of stockholders of this company, and their highest appreciation of the faithfulness, intelligence and success which have characterized his discharge of the duties of treasurer.

Voted—That the thanks of the stockholders be hereby extended to the retiring board of directors for their faithful and successful attention to the interests of the company.

Nearly 86,000 shares of stock were voted out of the entire capital of 100,000 shares, and every vote was unanimous.

## New Sodium Battery.

The *Bull tin* of the Societe Internationale des Telephones has recently announced the formation in Paris of a syndicate with a capital of 12,000*l.* for working the sodium battery lately invented by M. P. Jablochkoff. Whether such an organization has been, or is to be, established, says *Engineering*, we do not know, but space may well be devoted to a short notice of the battery referred to. In designing it M. Jablochkoff's object was to obtain an element having a much higher electromotive force than any other hitherto devised, and for this purpose he has made use of pure sodium. This metal is used in thin plates, and is coupled with compressed carbon, such as is employed in other batteries, or the plates may be placed in a metal capsule, in the midst of broken carbon. Under such conditions, and subjected only to the humidity of the air, the battery yields the relatively high electromotive force of four volts, which may be raised to six volts by impregnating the carbon with certain metalloid solutions.

This latter fact, however, has no practical value, because the price of such solutions, and the difficulty of using them, make the arrangement quite impracticable. With a couple of sodium and copper, the electromotive force falls to three volts. Such a battery, which may be of value in some cases, is made up of a thin plate of sodium, and a piece of red copper gauze. It will be seen that the force of this battery is considerably in excess of others now in use. So far as we know, there is not yet sufficient information as to the durability and the internal resistance of the sodium battery, to establish any useful comparisons with ordinary types. On account of the avidity with which sodium decomposes water and absorbs oxygen, it is necessary to shield the battery from exposure when it is not in use, and for this reason it should be kept, except when active, in a bath of naphtha, or at all events in a hermetically sealed vessel. M. Jablochkoff asserts that the waste of the sodium, that is to say, its combustion, beyond what is converted into useful energy, is extremely small. One of the objections, which naturally present themselves to this battery, is the great precaution which must be taken in using it, on account of the explosions which occur when sodium is brought into contact with water. With proper precautions, however, such a danger is not great, although more than one serious accident has happened from this cause.

* * F. W. Jones, one of the managers of the Institute of Electrical Engineers, has presented to the Buffalo Electrical Society a number of very valuable electrical works.

## The Conductivity of Copper.

The true nature of electrical resistance is by no means well known; and the only light which the induction balance of Professor Hughes has as yet shed upon it has not revealed its true nature. An interesting observation recently made by Mr. W. Groves, the well-known practical electrician of Bolsover Street, W., deserves to be more widely known. Mr. Groves took thin disks of brass and coated them by electro deposition with a thick layer of pure crystalline copper. He then cut similar disks of copper from the deposit, and tested them in the induction balance. The scale gave 200 as their induction value. The same disks, after being melted in a founder's furnace, only gave 100 on the scale, and after a second melting their induction value had fallen to nearly that of ordinary sheet copper, namely, from 50° to 80°. If, as many believe, the induction value represents the conductivity of the copper, there is here a great falling off, and it might be valuable, not only in a theoretical but a practical sense, to find out the true cause. Dr. Mathiessen found that copper lost in conductivity by absorption of oxygen, and the pure copper being fused in an ordinary founder's furnace may have lost its electric conducting power by absorption of this impurity. Should that prove to be the case, there is much to be gained by fusing copper in presence of hydrogen, which uniting with the oxygen would form water, and leave the copper in its pure condition.

—— The fine steamer Vancouver, which had her trial trip on the Clyde on Saturday, the 3d inst., and has since been handed over to her owners, the Dominion Line Company, of Liverpool, has been provided with an extensive electric light installation. It embraces some 300 Swan incandescent lamps of twenty candle-power each, and is one of the most complete afloat. The current is obtained from two of Siemens' compound shunt-wound dynamos, which are driven by two of Tangye's six-horse vertical engine. The machines are driven direct from the fly-wheels of the engines, the friction pulley on the axle of each dynamo being formed of compressed paper. Each dynamo is capable of maintaining 200 twenty-candle glow-lamps. Such entire reliance is now placed on the electric light that the owners of the Vancouver gave instructions to have the vessel throughout lit up by the means referred to. Every habitable portion of the vessel is brought within the range of the electric light, from the firemen's and seamen's quarters in the forecastle to the steward's quarters in the stern of the ship, and including also the whole of the passenger berths and the steerage quarters on the lower, main, and bridge decks. In the main saloon the lighting is provided by forty-one lamps, all of which are arranged as pendants from the ceiling; and in the music saloon and smoking room the lamps are fixed on handsome brackets secured to pilasters around the walls. In the port and starboard lighthouses at either end of the lookout bridge there are Swan lamps each of 100 candle-power for signal lights, the Board of Trade having consented to the use of electric lamps in that way, provided that the lighthouses are also furnished with oil lamps in case of emergency. For facilitating the stowage and discharging a cargo by night, arrangements have been made for powerful deck lanterns being hung over the hatches, each containing a cluster of three 100 candle-power Swan lamps.

—— The Germanic, the finest boat of the White Star fleet, has been fitted with electric light on Siemens' system in the most thorough and substantial manner. The total number of lamps employed in the interior illumination of the ship is 396; there are also two clusters of eight 40 candle-power lamps for cargo purposes, and the port and starboard signal lamps are each fitted with 100 candle-power Swan lamps. The machines employed are two Siemens self-regulating dynamos, each capable of supporting 300 lamps. Each machine is driven by a Tangye twelve horse-power vertical engine, with Raworth's cotton rope transmission. In the principal entrance there are six very handsome silver-plated single-light brackets disposed round the sides, and a central three-light pendant under the skylight.

## ELECTRIC LIGHT NEWS

—— Aberdeen, Miss., rejoices over a 40-light Brush installation.

—— Montgomery, Ala., people are happy over an 80-light Brush electric light plant, just established.

—— Mr. Ed. Raphael has a 150-light United States Electric Light plant in operation at Houston, Texas.

—— Waterbury and Meriden, Conn., are to have the electric light. Companies are being formed at both places.

—— Messrs. Hurley & Gray have a 50-light United States Electric Light plant running successfully at Mobile, Ala.

—— The Ball Engine Company, Erie, Pa., contemplate greatly increasing their capital stock and enlarging their operations.

—— At Louisville, Ky., W. C. Hall has an 80-light United States plant, and J. L. Smyser a 60-light Brush plant, in full blast.

—— The Jersey City Electric Light Company are contemplating putting in new boilers and engine, and otherwise reorganizing their plant.

—— The local Electric Light Company, of Galveston, Texas, have a 160-light Brush plant, giving excellent satisfaction. Colonel William H. Sinclair is president and managing director of the company.

—— The Mendota Electric Light Company, of Mendota, Ill., has completed its organization with the following board of officers: P. H. Cooper, president; Max A. F. Haass, secretary; E. A. Bowen, treasurer; L. R. Curtiss, superintendent and electrician. The company has adopted the Thomson-Houston system, and ordered a 25 light dynamo, to be run by an A. L. Ide 50 horse-power engine.

—— The Thomas Electric Light and Power Company, of Ottawa, Ill., has 75 Thomson-Houston lights, and contemplates extension by the addition of an incandescent plant. The Twin City Gas Company, of La Salle, Ill., has a plant of 25 Thomson-Houston lights now running, and its order has been given for another machine of the same capacity. The power is obtained at the Union Coal Shaft from an Ide automatic 50 horse-power engine.

—— When the royal yacht Osborne arrived in Portsmouth harbor, England, bearing the remains of H. R. H. the Duke of Albany, Mr. Lane, the dockyard electrician, fitted up the mortuary chamber with sixteen 50-candle power lamps, supplied with currents by wires from the apparatus on board H.M.S. Malabar. By the brilliant illumination thus given, several most successful photographs of the apartment were taken by Mr. West.

—— In the House of Lords, recently, the Earl of Milltown asked why the electric light, which had long since been successfully introduced into the House of Commons, had not been introduced into that House, and whether it was intended so to introduce it, and, if so, when? He complained that a vote had been granted for the purpose of introducing the electric light into both Houses, but, while the House of Commons had taken care of themselves, the House of Lords was left with an illuminant which had almost gone out of fashion for public buildings. Lord Sudeley, in reply, stated that the First Commissioner of Works had the whole question of lighting in the Houses of Parliament with the electric light now under consideration. Plans and estimates were being made out, and it was intended, if possible, to light up with the electric light not only the library, corridors, and lobbies, as had been done in connection with the House of Commons, but also, in this case, to light up the interior of the House of Lords itself.

### A New Soldering Apparatus.

Clear-headed line builders are coming to find that it adds materially to the efficiency of repaired and rebuilt lines to go over them after the wires have been put on the new poles, and carefully examine every joint, and thoroughly solder all that have not been soldered at some previous time, and that this not only adds to the efficiency of the line in a general way, but so perceptibly as to leave no question of the desirability of its being done in a painstaking manner.

The best of linemen leave bad joints in the wire from year to year, put in during a rush of work, that they intend to cut out at some future time, but which are overlooked. Going over a newly rebuilt line, two men, with a ladder, making this a special purpose, cannot help but improve the working of the line to a large extent. These men who have this work in hand should be men that will take an interest in the work, and have everything with them for doing good work. Where a joint is rusty and it is necessary to bridge it with No. 11 galvanized wire, a flat file (old, worn out one), ground to a sharp edge, is the best for preparing the joint for the jumper, as it is called. The joint is thoroughly scraped for an inch or two on each side of it, and then the No. 11 wire is jumped over the rusty joint and wrapped on each side of it, just the same as in making a half joint, and twisted, say, from five to six turns. After a new wire has been up a few years the number of joints that are put in the line is surprising, and soon average one to each span. A wire that has only been up a few

years, and where the joint is not rusty, can be soldered without a jumper, but the acid should be strong enough to cut the gummy grease off, and enable the solder to take hold. The best fire-pot to use is one that burns soft coal, as enough can be picked up along the track, and experience shows that it is much better than gasoline and alcohol, as well as cheaper. The soldering should be done in warm weather. If the line is rebuilt in the winter the soldering can be put off until the summer. It requires two men; one to work on the ladder to prepare the joints. When ready, he drops his rope and pulls up the pot, solders the joint and then lowers it to the man below. In order to give superintendents and foremen an idea of what can be done in a day, we give below the daily reports of two different jobs done by the W. U. and Penna. Cos. joint work.

To get good results, however, a satisfactory soldering apparatus is necessary, and Mr. Sam. Uhlich, of Mansfield, O., a practical line builder, and for many years the right-hand man of Supt. of Telegraph O.H. Booth, before the latter's death, seems to have devised an apparatus which, in the hands of his linemen on the P., Ft. W. & C. R. R., has been found to be superior to any other, and to answer every purpose. A cut of Mr. Uhlich's soldering-pot accompanies this article. From all that we can learn this apparatus seems to have all the advantages which Mr. Uhlich claims for it. As showing the rapidity with which the work can be accomplished with this apparatus, it may be said that on a line between Rochester and Pittsburg a record was kept of the joints soldered during a few weeks in one summer. The poles were forty feet long, and a very long ladder had to be used. There were three four-pin cross arms on the line, and ten wires, while the work was being done. In the space of less than five weeks (28 days), there were 2,400 joints soldered.

The Western Electric Company manufacture Mr. Uhlich's apparatus.

### What Is Electricity?

Electricity is the most stupendous force in nature, apparently active throughout the universe, the cause of the phenomena described as attraction, gravitation, and magnetism, and most probably of heat and light. It is incessantly active, and maintains, it would seem, the physical life of the world. Science can only appreciate some of its results, and apply it on a very limited scale to practical purposes; but knowledge of its adaptability is growing every day, and what a few years since was little more than material for brilliant laboratory experiment, or the production of scientific toys, is now becoming a gigantic motive power available for the service of practical science and the progress of civilization.

Already it provides a means of instantaneous communication between portions of the earth's surface, most remote from each other. It is gradually superseding all other methods of artificial illumination, and it promises to make steam obsolete as a motive power. What other aid it may give we know not, and we scarcely dare conjecture, although it would seem that the most vivid imagination must fail to apprehend its possibilities. It is in the earth beneath us, known as terrestrial magnetism; it is in the atmosphere around us, and its energy is seen in the lightning flashes which mark the discharge of force between clouds, each of which is a storage of force; and in the vast—indeed, inconceivable—cosmos, electricity maintains the relations of suns and systems moving with enormous velocity and unvarying regularity through space. It is a force which, so far as human intellect can appreciate it, knows no cessation, diminution, or deterioration. It can be summoned, but not created by any skill of man—made apparent in the results of friction or chemical action, but made apparent only, not produced. A spark the eighth of an inch long, produced by contact with the small electric machine in the lecture room, is precisely similar in character to the terrible flash which splits a tree to fragments, striking it with sudden death, or topples down the most massive tower reared by the skill of man In Oriental fable we read of lamps, the rubbing of which produced an obedient genius ready to minister to every wrath. We can excite the electric force, and the most stupendous of all the genii nature—if not, indeed, the master spirit, of which all known natural forces are but variations—is at our service; our servant, if we will—our most terrible master if we have no skill to conciliate him.—*Beeton's Dictionary of Science.*

### A Watch Made to be Pounded.

When a visitor to the office of the American Bank Note Company sat down to talk to Mr. Lee, that gentleman put a piece of white paper under a stamp, pounded on it and laid the paper aside. When the visitor arose to go away, Mr. Lee put the paper under the stamp again, and pounded it once more. "You talked eight minutes," said he; "that wasn't bad." He showed the piece of paper to the caller, who saw upon it two printed clock dials. One showed the hands at four minutes to four o'clock, the other showed them at four minutes past four o'clock. "We keep that stamp," said he, "so that you shan't go away and say you came here at eleven o'clock in the morning, or that you had to wait an hour and a half, or make any other misstatements which can be guarded against."

"No," he added a moment later; "that stamp is the latest wrinkle in office furniture. It is an ordinary stamp with a clock attachment. The hour hand is simply a raised point upon a movable circle. The minute hand is an arrow on another revolving circle. The usual inked tape passes over these indicators and the outer circle of hour figures. Beside the clock face is a cylinder with several faces, each bearing a word. One is 'Approved,' another is 'Wired,' and another is 'Answered;' others are 'Delivered,' 'Lee,' "Received.' Thus a business man is able, whenever he sends away a letter, telegram or package, receives an order, or transacts any business whatever, to record the precise moment at which the thing was done. It costs $20. I did not invent it. I bought it."

## ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENT OF THE UNITED STATES WERE GRANTED IN THE WEEK ENDING MAY 20, 1884.

298,751 Covering for electrical conductors; Frank S. Harrington, Providence, R. I., assignor to himself and Herbert N. Fenner, same place.

298,783 Receiving telephone; Charles E. Scribner, Chicago, Ill., assignor by mesne assignments to the American Bell Telephone Company, Boston, Mass.

298,906 Watchman's electric time detector; Christian G. Spengler, Hoboken, N. J., assignor to Electric Patrol Indicator Company, of New York.

298,913 Electric block signal for railways; Stephen James Swayze and John C. Lane, Sag Harbor, N. Y.

298,922 Armature for electric motors and dynamo-electric machines; Joseph C. Vetter and Stephen G. Putnam, New York, N. Y.

298,923 Telephone transmitter; Henry E. Waite, New York. N. Y., assignor to Charles F. Livermore, trustee, same place.

298,924 Telephone receiver; Henry E. Waite, New York, N. Y., assignor to Charles F. Livermore, trustee, same place.

298,925 Telephone transmitter; Henry E. Waite, New York, N. Y., assignor to Charles F. Livermore, trustee, same place.

298,945 Signal box for district and fire-alarm telegraphs; Charles H. Carter, Brooklyn, N. Y.

298,954 Dynamo-electric machine; Thomas A. Edison, Menlo Park, N. J.

298,955 Dynamo-electric machine; Thomas A. Edison, Menlo Park, N. J.

298,956 Mode of operating dynamo-electric machines; Thomas A. Edison, Menlo Park, N. J.

298,975 Telegraph pole; James Hunter, Ruffs Dale, Pa.

298,997 Electric battery; Oscar Millard, Flint, Mich., assignor of one-half to Charles B. Crampton, same place.

299,011 Watchmen's electric recorder; Jerome Redding, Malden, assignor to himself and Harvey Redding, Everett, Mass.

299,021 Apparatus for charging secondary batteries; Robert Percy Sellon, Surbiton, county of Surrey, England.

299,025 Electric arc lamp; Sidney Howe Short, Denver, Col.

299,039 Electric multiple switchboard system; Theodore N. Vail, Boston, Mass.

299,070 Telephone exchange system; F. Benedict Herzog, New York, N. Y.

299,073 Telephonic transmitter; Jose Dottin Husbands, London, England, assignor to the American Bell Telephone Company, Boston, Mass.

299,074 Telephonic receiving instrument; Jose Dottin Husbands, London, England, assignor to the American Bell Telephone Company, Boston, Mass.

**A printed copy of the specification and drawing of any patent to the annexed list, also of any patent issued since 1865, will be furnished by any of the patent solicitors whose advertisements appear in this journal. In ordering please state the number and date of the patent desired.**

### A New Standard Light.

Herr Hefner-Alteneck has suggested a new standard light for photometric purposes, which promises to be very simple and effective in operation. The light is produced by an open flame of amyl-acetate burning from a wick of cotton fibre which fills a tube of German silver 1 in. long and 316 mils. internal diameter; the external diameter being 324 mils. The flame is 1.58 in. high from top to bottom; and it should be lighted at least ten minutes before using the light for testing. A cylindrical glass chimney surrounds it to ward off air currents. About 2 per cent. of the light is absorbed by the glass. The power of the flame is that of a standard English candle; and experiments have shown that amyl-acetate, which besides is not expensive, is the best fuel for steadiness and brilliance. Neither the substitution of commercial amyl-acetate for pure, nor the use of a wick of cotton thread for loose cotton fiber alters the illuminating power; but the wick should be trimmed square across the mouth of the tube, for if it project and droop the illuminating power is increased.—*Engineering.*


## BUSINESS NOTICES.

A. C. NORTHROP, Waterbury, Conn. Iron and Brass Machine Screws, Zinc in Sheets and Plate for Electrical Purposes, Parts for Telephone and Telegraph Instruments, Manufactured from Iron, Brass, Steel or Zinc.

A. G. DAY, Kerite Insulated Telegraph and Telephone Wire and Cables, Anti-induction Kerite Telephone Cables, CLARKE B. HOTCHKISS, New York. Send for circular and prices.

ALFRED F. MOORE, Philadelphia, Pa. Telegraph, Telephone, Electric Light, Office, Line and Annunciator Wire.

AMERICAN BELL TELEPHONE Co., Boston, Mass. Electric Speaking Telephones for Exchange Systems, Private Lines, and Speaking-tube Lines.

AMERICAN ELECTRICAL WORKS, Providence, R. I. Patent Finished Insulated Electric Wires, Telephone and Electric Cordage. Electric Light Wire, Magnet Wire, Patent Rubber covered Wire. Aerial and Underground Cables, &c., &c. Send for prices.

AMERICAN INSULATOR COMPANY, New York. Insulators of all sizes.

AMERICAN SPIRAL TELEPHONE WIRE Co., Boston, Mass. Spiral Telephone Wire for long and short distance Telephoning. Write for information.

ARMINGTON & SIMS, Providence, R. I. Engines for Electric Lighting and general use.

AUSTIN GALLAGHER, New York. Keith Electric Light System complete for Arc Lighting. Stock for sale.

BAXTER ELECTRIC LIGHT COMPANY, New York. The Baxter Lamp.

B. W. PAYNE & SONS, Corning, N. Y. The Payne Single and Double Valve Automatic Engine. Send for catalogue.

BERGMAN & Co., New York. The Bergman and Haid Battery for Telephone and Telegraph purposes. Send for circular.

BOULTON CARBON Co., Cleveland, Ohio. Carbons for Electric Light purposes. Send for quotations.

BROWNLEE & Co., Detroit, Mich. Telegraph and Telephone Poles.

BRUSH ELECTRIC Co., Cleveland, Ohio. Arc Lights and Brush Storage Batteries.

BUFFALO ELECTRIC WORKS, Buffalo, N. Y. Carbon Points and Plates.

BUTLER HARD RUBBER COMPANY, New York. Rubber Insulators and Electrical Supplies of every description.

BUTLER SAFES, New York. Fire and Burglar-Proof.

CHARLES WILLIAMS, JR., Boston, Mass. Call Bells, Electric Bells, District Bells, Switch Boards, Annunciators, &c., &c. Write for quotations.

CHICAGO INSULATING Co., Chicago, Ill. The Fiske-Mott High-resistance Insulator. Send for circular.

CHROME STEEL WORKS, Brooklyn, N. Y. Steel for Magnets a specialty; Chrome Cast Steel.

COE BRASS Co., Torrington, Conn. Brass, Copper and German Silver in every variety of Sheets, Rolls, Plates, Wire, Rods and Blanks or Shells. Pure Lake Superior Copper Wire and Battery Zincs. Write for price list.

CONNOLLY BROTHERS, New York, Patent Attorneys and Solicitors.

CORNELL UNIVERSITY, Ithaca, N. Y. Electrical Engineering.

D. VAN NOSTRAND, New York. Scientific Books. Send for circular.

ELECTRIC STORAGE AND LIGHT Co., Boston, Mass Own patents for Faure's Storage Batteries for territory of Rhode Island, Connecticut and Massachusetts.

ELGIN STEEL TOWER COMPANY, Elgin, Ill. Electric Light Towers.

GILLILAND MANUFACTURING COMPANY, Indianapolis, Ind.

GREAT SOUTHERN TELEPHONE COMPANY, Nashville, Tenn. Gilliland Switchboards.

HARVEY, STAFFORD & Co., Acton, Ont., Canada Telegraph and Telephone Poles.

H. M. RAYNOR, New York. Platinum for all purposes.

HOLMES, BOOTH & HAYDENS, New York. Fireproof Electric Light Wire, Patent "KK" Insulated Copper and Iron Wire for Telephone and Telegraph use. Send for catalogue and prices.

I. W. COLBURN & Co., Fitchburg, Mass. Dynamo Electric Machines.

IVISON, BLAKEMAN & TAYLOR, New York. Ink of all kinds and colors. Circulars sent on application.

J. O. SHIRAS, Cincinnati, O. Telephone Stocks bought and sold.

JARVIS ENGINEERING COMPANY, Boston, Mass. Boilers set with the Jarvis Patent Furnace.

JOHN H. MUEGGE, New York. Platinum, Chemical Apparatus, Crucibles, etc.

LECLANCHE BATTERY COMPANY, New York. The Great Telephone Battery. Write for description and prices.

J. H. BUNNELL & Co., New York. The Morse Learner's Instrument, Telegraph Instruments of all kinds, Telephone and Telegraph Supplies. Illustrated Works on Electrical Measurement, and the Galvanometer and its uses. Send for catalogue.

LAW TELEGRAPH Co., New York. The Law Battery for Telephone and Telegraph purposes.

LOCKWOOD & FOSTER, New York. Learners' Telegraph Instrument.

MUTUAL DISTRICT MESSENGER Co., Boston, Mass. Addressing and Distributing Circulars &c., &c. D. J. Hern, General Manager.

NATIONAL ELECTRIC COMPANY, Washington, D. C. Electrical supplies and apparatus.

NEW ENGLAND BUTT COMPANY, Providence, R. I. Braiding Machinery for covering Telegraph, Telephone and Electric Light Wire, Single and Double Winders and Braiders of every description; also Fine Castings. Send for catalogue.

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PAINE & LADD, Washington, D. C. Attorneys in Patent Causes, and Solicitors of Patents.

PALMER WIRE Co., Palmer, Mass., and New York. Galvanized Telephone and Telegraph Wire Iron and Steel Wire of best quality, Material, finish and conductivity. Write for quotations.

PARTRICK & CARTER, Philadelphia, Pa. Electric Annunciators, Learners' Instruments, Batteries and Telegraph and Telephone Supplies. Write for circulars.

PHOSPHOR BRONZE SMELTING Co., Philadelphia, Pa. Telephone Wire, Insulated and bare.

RHODE ISLAND TELEPHONE & ELECTRIC Co., Providence, R. I. Manufacturers of the Providence Telephone Switch Boards, Breckenridge Jacks, Wright Cable Clips, Howard Safety Appliances, &c.

ROYCE & MAREAN, Washington, D. C. Dealers in Electrical apparatus, Telegraph and Telephone supplies.

SCHLEICHER, SCHUMM & Co., Philadelphia, Pa. Manufacturers of the Otto Gas Engine. Write for catalogue.

THE FREEMAN & ROE ELECTRICAL SUPPLY COMPANY, New York. Electric Light Machines, Motors, Dynamos, Telegraph and Telephone Apparatus.

STANDARD ELECTRICAL WORKS, Cincinnati, Ohio. Manufacturers of Telegraph and Telephone Instruments, Magneto Bells, Switch Boards and Telephone Exchange Apparatus, Annunciators, Wire, Batteries, Insulators, Electric Light Wire and Supplies. Send for circular and prices.

SWAN INCANDESCENT ELECTRIC LIGHT CO., New York. Incandescent Lights, and Complete Apparatus. Send for illustrated catalogue.

THE ANSONIA BRASS AND COPPER CO., New York. Pure Electric Copper Wire for Magnets, Telephone Lines, and Electric Light purposes, Office Wire, Zinc Rods and Battery Copper.

THE BISHOP GUTTA PERCHA WORKS, New York, Gutta Percha Insulated Submarine Telegraph Cables Subterranean Telegraph Cables, Aerial Telegraph Cables, Lead or Hempen covered Torpedo Cables, Lead-covered Cables, Telephone Cables of all kinds —G. P. Office Wire, and Marks' Compound Insulated Wire, &c., &c. Send for catalogue.

THE BUTLER HARD RUBBER COMPANY, New York. Electrical supplies, Rubber Hook Insulators, Hardwood Tubes, Plug Handles, Lamp Switch Handles, Battery Syringes, etc.

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THOMSON-HOUSTON ELECTRIC Co., Boston, Mass. Automatic Self-regulating System of Arc Lighting.

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TRENTON IRON Co., Trenton, New Jersey. Galvanized Iron and Steel Wire of all kinds for Telephone and Telegraph purposes. Write for prices.

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WATTS, CAMPBELL & Co., Newark N. J. Improved Corliss Steam Engines. Send for catalogue.

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The Sole Manufacturers under all the Patents of CHAS. F. BRUSH for
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We furnish the only complete and PERFECT SYSTEM of electric lighting.
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STANDARD SIZES.

| No. of Mch. | No. of Lights 2,000 c. p. | No. of Lights 1,200 c. p. | Horse Power Required | Price. |
|---|---|---|---|---|
| 2 | 1 | | 1½ | $300.00 |
| 2 | | 2 | 1½ | 300.00 |
| 3 | 2 | | 3 | 415.00 |
| 3 | | 3 | 3 | 415.00 |
| 4 | 4 | | 4 | 565.00 |
| 4 | | 6 | 4 | 565.00 |
| 5 | 10 | | 8 | 900.00 |
| 5 | | 15 | 8 | 900.00 |
| 6 | 20 | | 14 | 1,500.00 |
| 6 | | 30 | 14 | 1,500.00 |
| 7 | 30 | | 22 | 2,000.00 |
| 7 | | 45 | 22 | 2,000.00 |
| 8 | 65 | | 45 | 3,600.00 |

**Average Market Quotations of Battery Supplies for the Week Ending May 31ts, 1884.**

| | |
|---|---|
| Leclanche Disque Cell, complete | $1.25 |
| " Prism " " | $1.67 |
| " Prisms, per pair | $1.00 |
| " Carbon Mounted | 30c |
| " Jar Cover | 12c |
| " Sal Ammoniac, in bag | 8c |
| " Porous Cell | $1.10 |
| " Glass Jar | 18c. |
| " Amalgamated Zinc | 10c. |
| " Rubber Bands, per pair | 6c. |
| Chlorine Battery, per cell | $1.25 |
| Law Battery, per cell | $1.25 |
| " Jar and its Rubber Ring | 25c. |
| " Cover, with small Carbon sealed in | 35c. |
| " Large Carbons, each | 20c. |
| " Carbon Connector | 12c. |
| " Zinc Connector | 8c. |
| " Rubber Bolt | 12c. |
| " Zinc and its Rubber Ring | 12c. |
| Bergman & Haid, per cell | $1.20 |
| Crow foot, 6x8, per cell | 75c. |
| Callaud Zincs | 30c. |
| " Coppers | 15c. |
| " Jars | 25c. |
| Sal Ammoniac, per lb | 15c. |
| Blue vitriol, per lb | 10c. |
| " " bbl., lots, per lb | 5½c. |
| Sulphate of zinc | 10c. |

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PATENT
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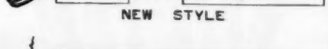
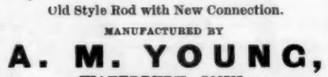


NEW STYLE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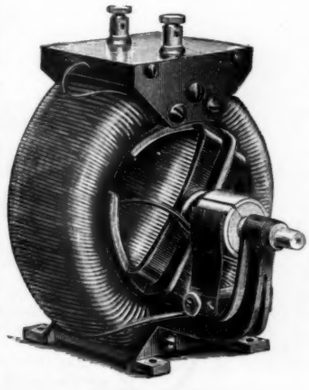

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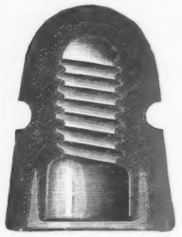

"DOUBLE PETTICOAT."

*To the American Insulator Company of New York.*

GENTLEMEN, New York, April 20, 1884

I have made several careful comparative tests of your "DOUBLE PETTICOAT" Glass Insulator and the ordinary glass insulator heretofore universally used by the different Telegraph and Telephone Companies, and as a result find the SUPERIORITY of your Double Petticoat Insulators to range from 30 TO 88 PER CENT; the highest per centage of superiority occurring in the worst weather, just the time it is most needed.

Yours truly, G. A. HAMILTON, ELECTRICIAN, WESTERN UNION TELEGRAPH CO.,

**We have two sizes of the larger "Double Petticoat" Glass, viz. 22 ounces and 18 ounces.**
**Price, for 22 ounce "Double Petticoat" Insulators, 6½ cents net, delivered on the dock at New York.**
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**Price, for Standard, 4 cents net same terms as above.**
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| B. & S. Gauge. | Resistance per Mile. | Breaking Strain. | Twists in 6 inches. | Price per Mile. |
|---|---|---|---|---|
| No. 12.... | 8.8 ohms. | 355 lbs. | 60 | $27.00 |
| 13.... | 10.5 " | 235 " | 69 | 23.00 |
| 14.... | 13. " | 205 " | 78 | 18.50 |
| 15.... | 17.3 " | 165 " | 86 | 14.50 |
| 16.... | 23.8 " | 130 " | 94 | 10.00 |

Put up in continuous lengths of one-half or one mile, as desired.

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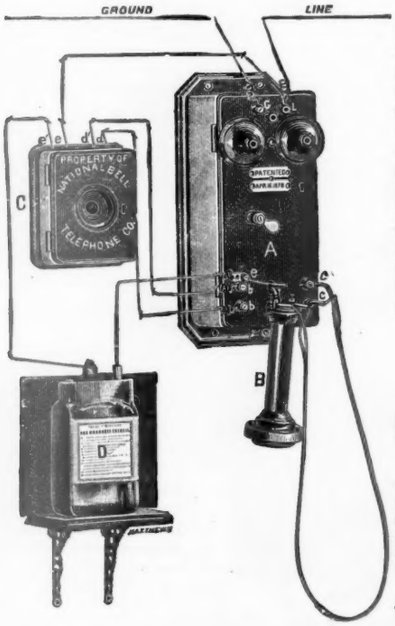
THE
# American Bell Telephone Co.

WM. H. FORBES, *President.* THEO. N. VAIL, *Gen'l Manager.* WM. R. DRIVER, *Treasurer.*




This Company owns the Original Patents of Alexander Graham Bell for the Electric Speaking Telephone, and other patents, covering improvements upon the same, and controls, except for certain limited territory, under an arrangement with the Western Union Telegraph Co., the Gold and Stock Telegraph Co., the American Speaking Telephone Co., and the Harmonic Telegraph Co., the Patents owned by those Companies, and is prepared to furnish telephones to the citizens of the United States through its local Licensees, on the following systems:

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**PRIVATE LINE, &**
**SPEAKING TUBE LINES**

*Those desiring instruments on Private or Speaking Tube Lines, or connections on Exchanges, will please apply to the nearest Licensed Exchange, when their case will be brought to the attention of the proper local Company.*

*Any further information will be gladly furnished on application to the Company at its office,*

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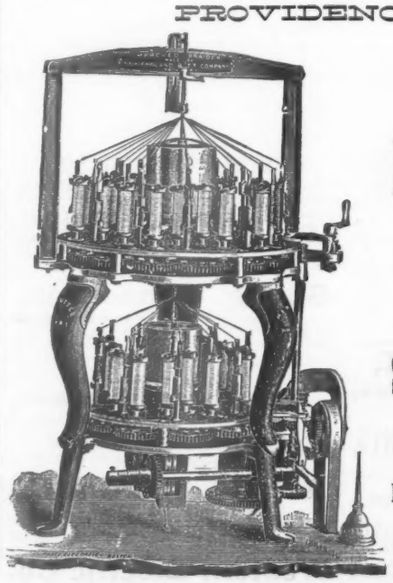

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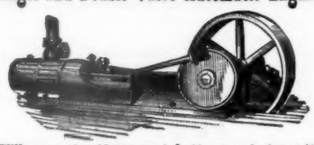

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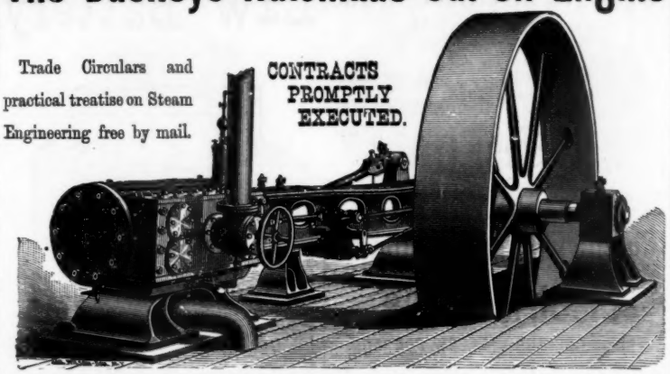

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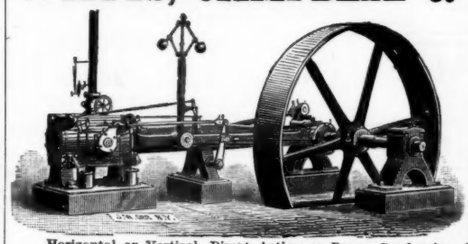

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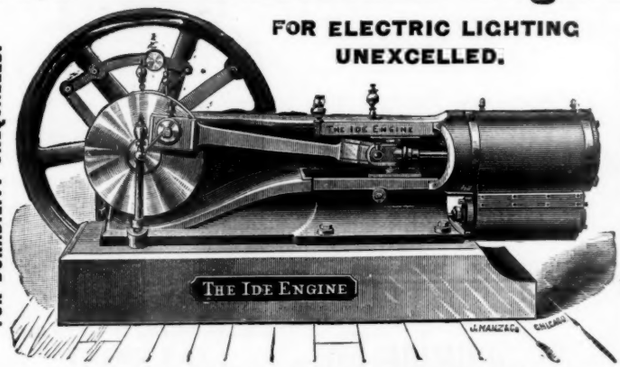


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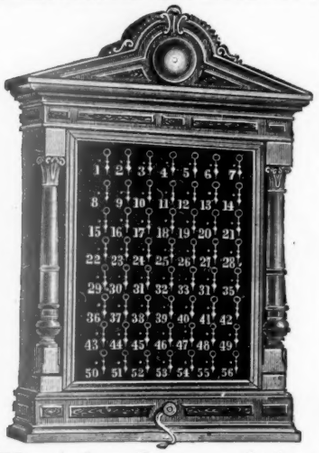

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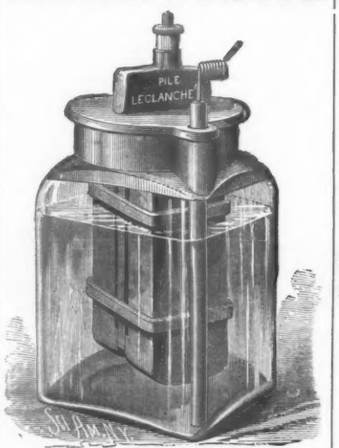


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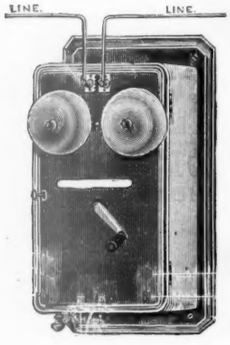


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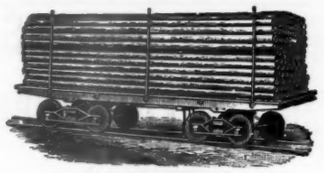

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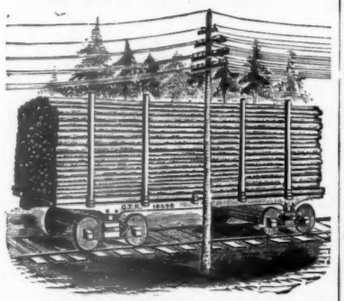

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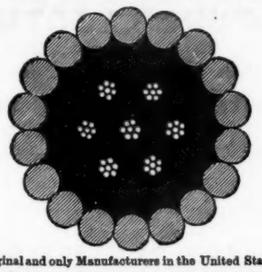

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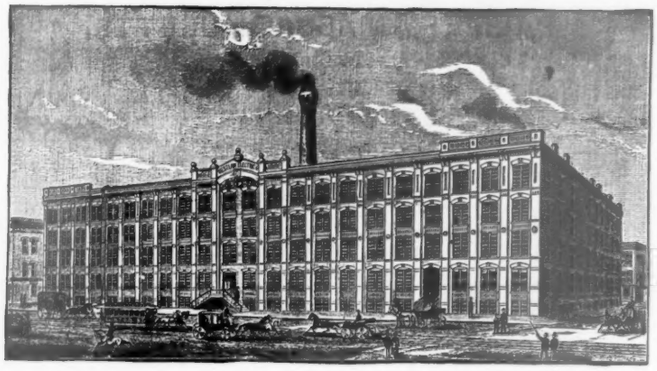

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